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ABSTRACT

The design considerations, criteria, and requirements for a proposed Alabama Resources Information System (ARIS) are reported. ARIS is based on the McHarg approach of composite mapping techniques and is planned as an evolutionary system. The system will be automated and adaptable to user needs and inputs and to the requirements of various federal agencies working with land use retrieval system. (Author)

ED 094769

ARIS

ALABAMA RESOURCES INFORMATION SYSTEM

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ALABAMA DEVELOPMENT OFFICE

George C. Wallace, Governor
R. C. "Red" Bamberg, Director
W. M. "Bill" Rushton, Assistant Director
Bill J. Starnes, Director
State Planning Division

PREPARATION OF THIS DOCUMENT

Approved by: Bill J. Starnes, Director
State Planning Division

Authored by: D. W. Dison, B. E. Herring,
R. I. Vachon, B. Wysong

Departments of Economics & Geography,
Industrial Engineering, Mechanical Engineering

ENGINEERING EXPERIMENT STATION

AUBURN UNIVERSITY

U S DEPARTMENT OF HEALTH
EDUCATION & WELFARE
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A R I S

ALABAMA RESOURCES INFORMATION SYSTEM

ALABAMA DEVELOPMENT OFFICE

State Planning Division

State Office Building

Montgomery, Alabama

June 1974

PROJECT PERSONNEL

R. I. Vachon

D. W. Dison

K. Crawford

M. Spradley

B. E. Herring

B. Wysong

D. Graham

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ABSTRACT: The purpose of this report is to present the design considerations, criteria, and requirements for a proposed Alabama Resources Information System (ARIS). The proposed system is based on the McHarg approach of composite mapping techniques and is planned as an evolutionary system. It will be adaptable to user needs and inputs and to the requirements of various federal agencies working with land use retrieval systems.

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LIST OF TERMS

BATCH MODE	Computer operates on all program steps between successive communications with the user.
CHOROPLETH MAP	A choropleth map is drawn on a quantative areal basis and is calculated as average value per unit area; e.g., the density of people per square mile.
COBOL	(COmmon Business Oriented Language) A computer programming language used for commercial and large data handling applications
FORTRAN	(FORmula TRANslation) A computer programming language generally used for scientific and mathematical applications.
INTERACTIVE MODE	Computer may operate on as few as a single program step between successive communications with the user.
MODULAR PROGRAMMING	Division of entire systems into individual problems or tasks that can be assigned to different personnel to solve and then be placed together to form a system.
PL/1	(Programming Language One) A computer programming language which has been designed to combine the attributes of both COBOL and FORTRAN.
PROXIMAL MAP	A map which is generalized and approximated according to dominant activity which is taking place between any two selected points.
STRUCTURED PROGRAMMING	Programming concept that permits large problems to be tackled in an organized manner. Based on a division of the problem into smaller pieces, simplified control structures, and the use of management techniques to implement large systems.
SUBROUTINES	A set of computer programming instructions that can be used separately to solve a task in a program.

CHAPTER I. INTRODUCTION

This report describes a proposed earth resources information system for the State of Alabama. This system is referred to as ARIS (Alabama Resources Information System). The report outlines the basic considerations necessary to develop a computer based information system that is user oriented. The study and the proposed system are predicated on the work elements provided by the Alabama Development Office (ADO) to the study team. These work elements contained in Appendix I encompass Demographic Characteristics, Land Use Development, and Automation of the Land Use System.

Concurrent with the ADO contract to conduct this effort, Auburn University has a contract with the Marshall Space Flight Center (MSFC) of NASA to continue the current effort subsequent to June 30, 1974. MSFC is supplying some of the computer time and a remote computer terminal to the study team to aid in demonstrating the proposed plan. The computer codes necessary to support the plan are being developed on the Auburn computer system which does not have a remote capability and hence the necessity for the MSFC supported demonstration program. Ultimately the State is expected to implement the system as demonstrated by the study team.

Subsequent sections constitute the background for the development of ARIS.

Information System Concept

The central tenet of economics is that resources are limited in supply while the demand for those resources is essentially unlimited. Thomas Malthus

looked at one resource, food supply, and reasoned its linear growth would not match the exponential growth of population. Since Malthus' time there have been significant improvements in the world supply of food. Mankind, however, has begun to realize that corresponding improvement cannot be made in the supply of other resources, e.g., clean air and fossile fuels. Resources are increasingly recognized as not being inexhaustible or infinitely renewable. More importantly, the interdependence among resources is now being recognized. This is expressed by the term "Spaceship Earth" and was dramatized by the pictures of Earth taken by the Apollo astronauts. This belatedly encountered consciousness requires careful management of resources.

Resource management has been essentially non-existent. Managers of organizational units have always used information to aid them in the making of decisions. Computerized data processing is a relatively recent arrival on the management scene. Only since the availability of this device has there been much talk or concern about the information problem. The computer has made it possible to process much more data than ever before, yet the manager is often starved for want of information.

Society is now confronted with what has been termed the "information explosion". Since information is data that has been processed in some way directly by a person or indirectly by him through a computer and is in a useful form, it might be better to term this inundation of facts a data explosion. The flood of factual material has produced peculiar problems. On one side, scientific researchers are confronted with vast amounts of literature to be searched when starting an investigation. Figure I-1 illustrates the many routes which "information" travels in the domain of science. If fortunate, a researcher may tap the pools in an effective and

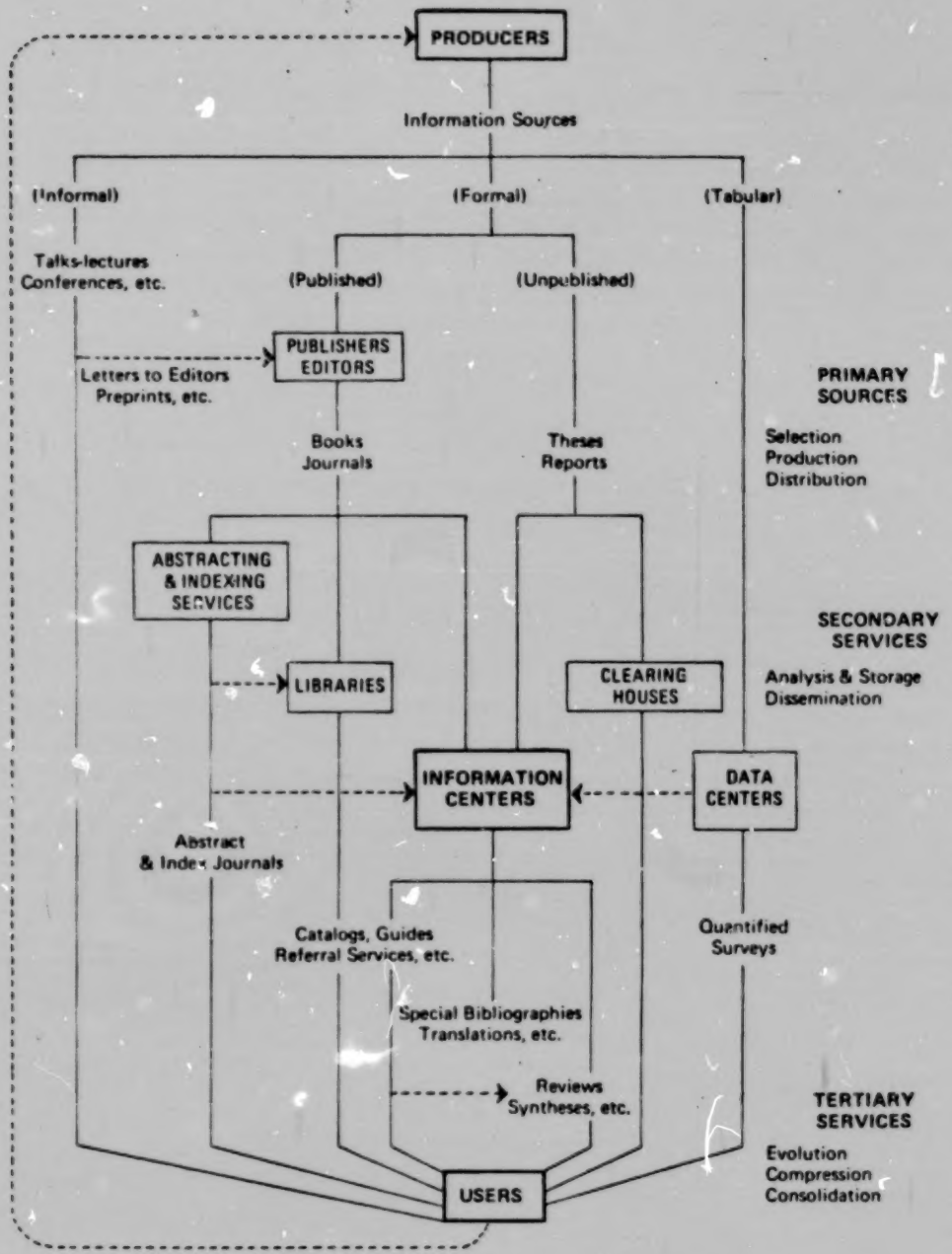


FIGURE 1-1. FLOW OF SCIENTIFIC-TECHNICAL INFORMATION (1).

efficient manner, thus quickly determining the present "state of the art". Conversely, managerial decision makers and personnel involved with control and direction of resource interactions find a severe lack of sufficient pertinent information. This is illustrated by the painful experiences of public utility firms and governmental agencies when attempting to assemble environmental impact statements for contemplated construction projects.

ARIS is proposed to offer a method for converting the raging flood of data into calm, useful information. Information systems attempt to solve the information problem by providing relevant information in the right form to the right person at the right time. Dr. A. F. Goodman, a retrieval expert, describes a good information system as "an accessible and rapid conveyor belt for appropriate high-quality information from its generator to its user.

John H. Norton, a planning manager with Raytheon, notes "An information system is a means to an end and not an end in itself. The system's documents, figures, and pictures should be used as a means to manipulate, to index, and to display information. Such a system gives what is asked of it; it does not make judgments regarding the use or quality of its contents. This determination is the user's job."

Alabama resources can be defined to encompass the totality of earth resources (those parts of the natural and man-made physical environment which are presently or potentially useful to man) within the domain and political boundaries of the State of Alabama. Figure I-2 is included to illustrate the scope of such resources which ultimately must be included in a useful information system.

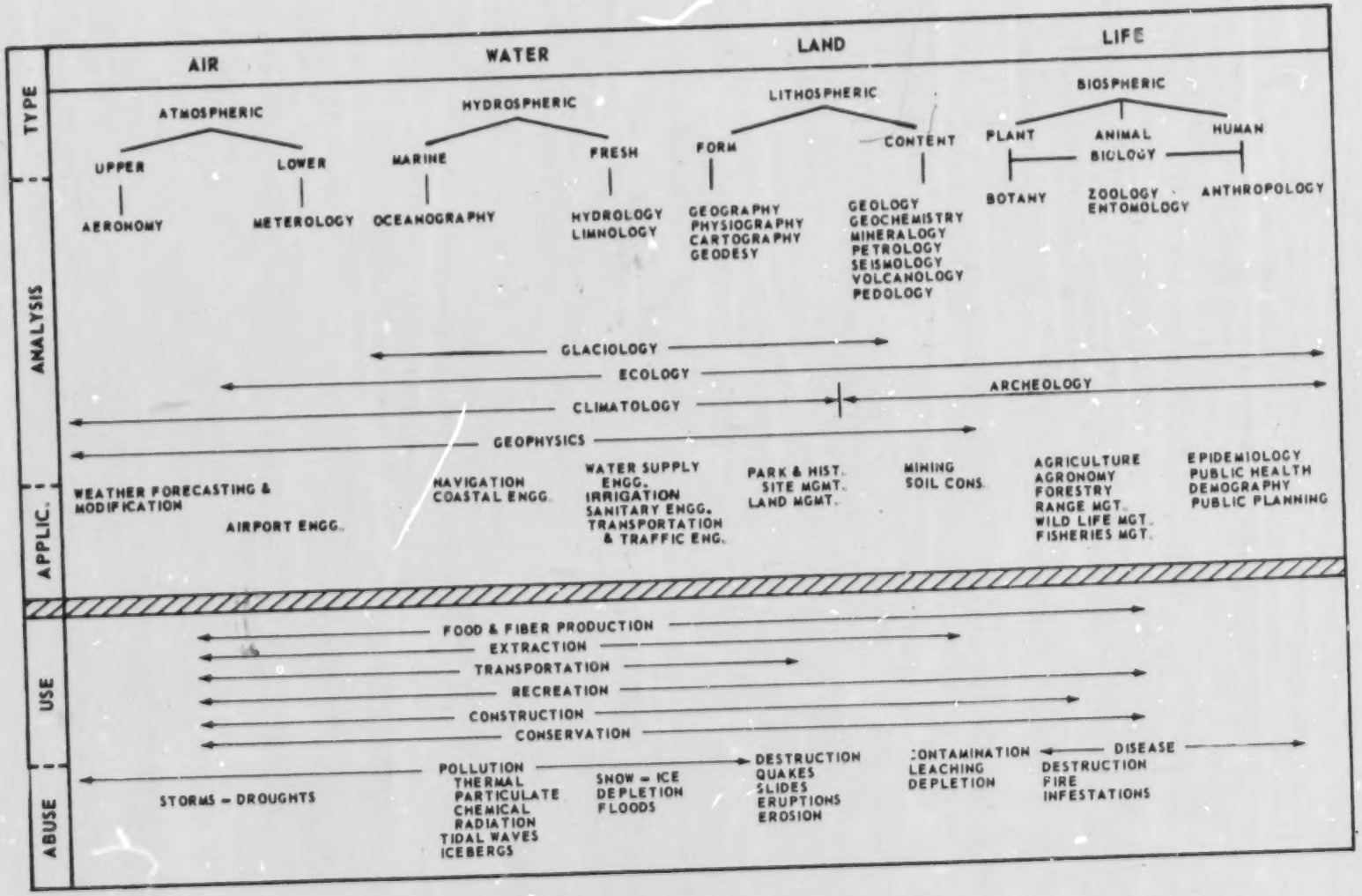


FIGURE 1-2. EARTH RESOURCES CATEGORIES AND RELATIONSHIPS.

An attempt has been made to call attention to the need for information to permit managers to manage with a reasonable degree of certainty. Another elements of management is also required. This element concerns the management of information. Management information systems have tended to resemble reactions to the torrents of data released on man, along with the large quantity of requests for information from that data. Carefully planned action to manage the information is the real solution to the problem.

Figure I-3 is intended to illustrate the present conditions with regard to the data and information situation for earth resources. The problems and issues are multi-dimensional and growing. The existing and emerging bodies of possibly pertinent data and information are diverse and very large. Means must be designed to enable order to replace the current situation.

A rather lengthy and growing list of terminology has developed since the introduction of the computer. One of the newer terms is "information management system" or IMS for short. This term, IMS, is intended to describe a more formal, organized approach to handling, coordinating, enhancing, and augmenting data and information supply and demand among multiple organizations. The distinction concerning multiple organizations is crucial, since the terms "information system" and "management information system" usually relate to a single organization.

This difference is highlighted by a functional description of a management information system. A management information system aims to serve the managerial personnel of an organization (public or private) with timely, decision-oriented information concerning the organization's operation and performance. A computer is usually employed in such an activity but is not always a necessary feature. Embryonic features of today's management information systems have existed since mankind began feeling the need for records.

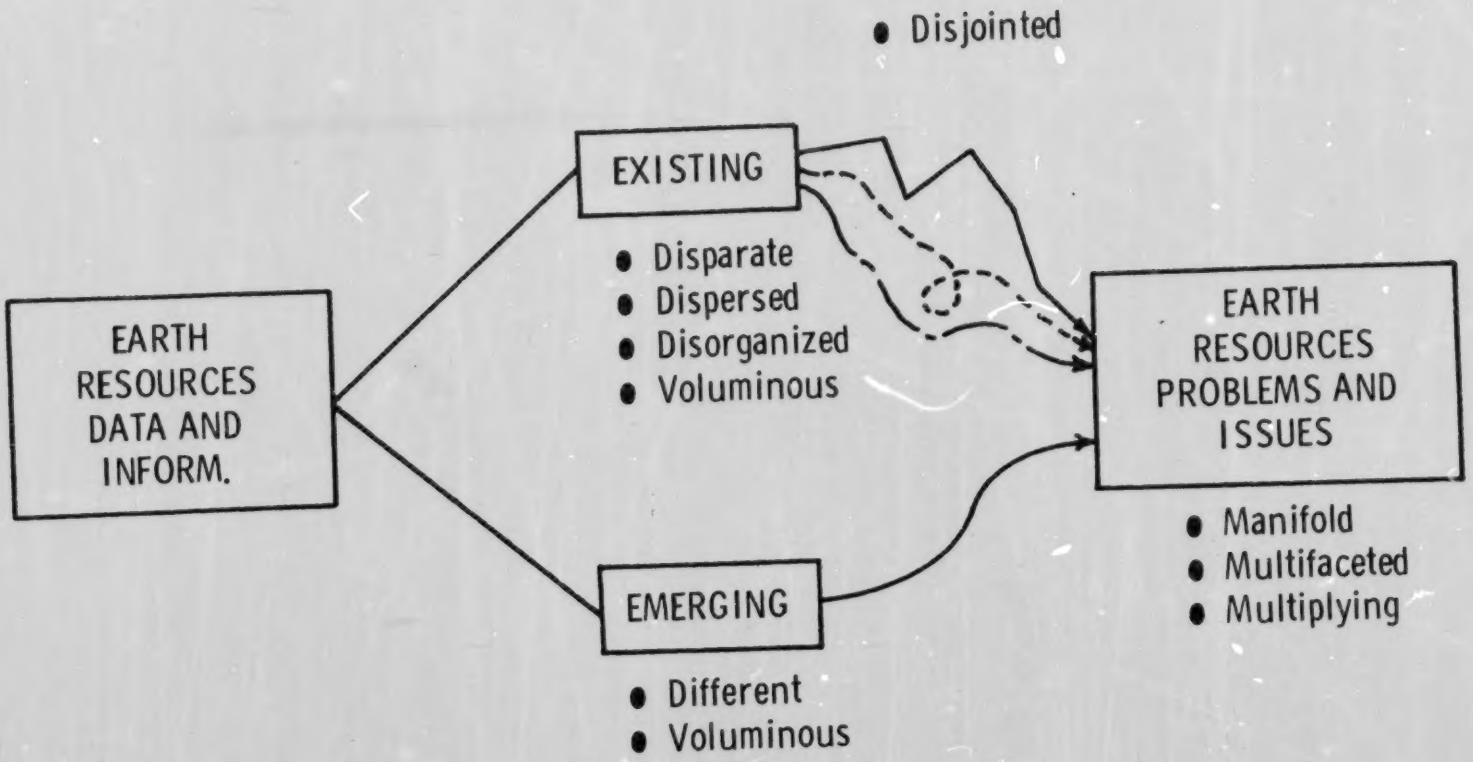


FIGURE 1-3. PRESENT DATA AND INFORMATION SITUATION FOR EARTH RESOURCES.

Information management system, both as a term and as a concept, has not yet gained widespread use in the field of information science and data processing. The final evolutionary state of ARIS should approximate the structure of a system for information management. It is acknowledged that the initial structure of ARIS will be of the nature of a purposeful management information system. Figure I-4 is included to serve as an illustration of the direction the evolutionary effort should take. The clarity of the latter flow should be compared with that depicted in the previous figure.

Project Preview

A survey has been made to determine a sample of earth resources information systems which have been implemented in various localities. No single, wide-ranging system appears to physically exist. Numerous land use planning and land use inventory procedures have been developed. All have been found to be in varying stages of implementation and modification. A number of information display aids and screening procedures for computer operation have been noted. Those appearing to have ARIS application are discussed in Chapter II of this report.

Because of the type of immediately available data, the system will initially be geographically and geologically oriented. Present planning calls for data conversion to a square grid for digital input to the many separate files. Chapter III presents a discussion of data, data input forms, and the planned system test areas.

Output display availability is to consist of tabular listing, line printer "mapping", three-dimensional plotter graphics, and various types of cathode-ray tube presentations. These are discussed in detail in Chapter IV.

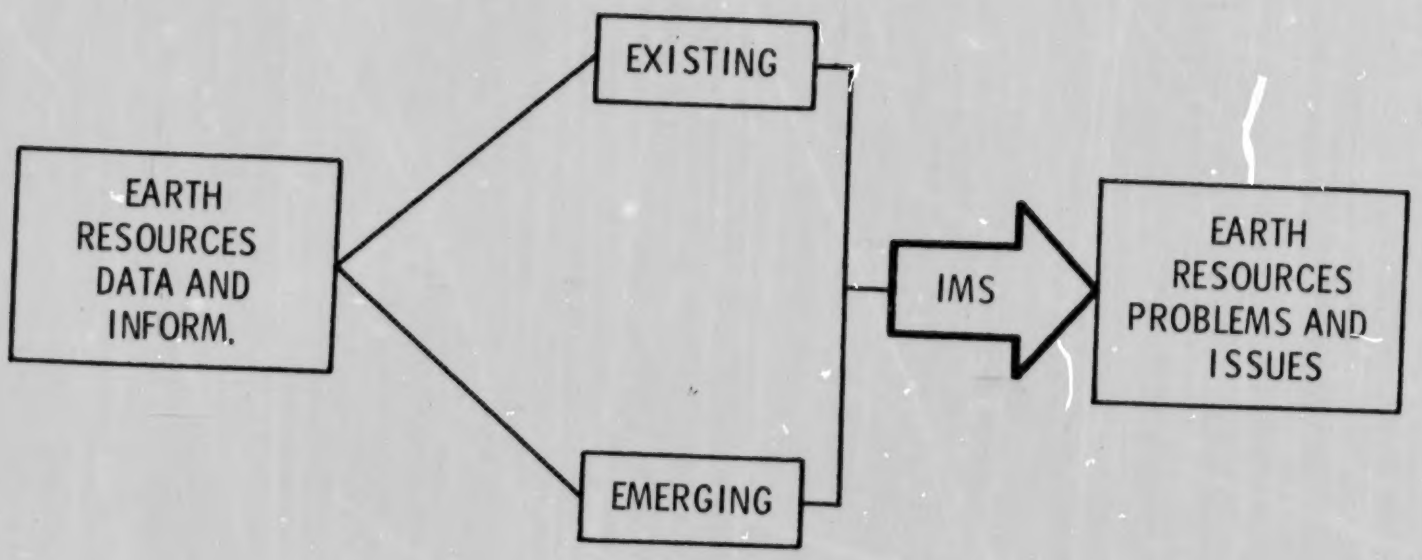


FIGURE 1-4. DATA AND INFORMATION SITUATION FOR EARTH RESOURCES WITH AN IMS.

The information processing system software is primarily in the conceptual stage, although some commercial packages have been ordered for evaluation for possible inclusion. Plans call for a three phase system development. Only the first portion is considered to be included in this project. The initial system will infrequently exercise system control of a set of predefined special purpose subprocedures. A detailed discussion of this system is presented in Chapter V. Included also is a look to the future in the outlining of future evolutionary phases of ARIS. Neither of the latter should be attempted until the initial phase has been implemented.

Chapter VI presents the concerns and concepts to be included in the management responsibilities of ARIS. This segment of the system is detailed to the point of illustration of a feasible management function structure.

REFERENCES

1. United Nations Educational, Scientific and Cultural Organization and the International Council of Scientific Unions, UNISIT: Study Report on the Feasibility of a World Science Information System, Paris: UNESCO, 1971.

CHAPTER II. EXISTING PROCESSING PROGRAMS AND PROCEDURES

A recent review of research shows efforts at retrieval system development to be directed towards procedures for selecting bibliographical, article, and abstract types of information. Data required for mapping, developing geographical tables, land use planning, and site selection are primarily numeric. Many information retrieval systems incorporate fairly rigorous coding and/or keyword structures. Individual differences or preferences can have a significant effect on the level of user preferences with the results from the retrieval activity. Rigorous structures presuppose standard preferences and values which do not exist within a set of possible users or even uses of a retrieval system.

One theoretical procedure, Nonparametric Multivariant Attribute Retrieval, is a file screening method which recognizes and permits the existence of individual user differences during the screening process. Accomodation of individual preferences is performed by utilizing the user's order of attribute importance within the various file entities. Additionally, the procedure for handling the sequence of attribute importance is flexible, since the user may have different objectives during separate searches of the data file. A key to the operation of this procedure is the process of connecting mathematically relatable weights to each attribute of the set of file entities during the retrieval activity.

Weighting is accomplished by using the exponential technique. Once the user establishes the importance ranking of the set of attributes, exponential weighting accomodates the implied order of preference. This

method exhibits the features of ease of use, of mathematical relatability, of being recursive, and of allowing uncomplicated computer operation. Once the user has defined the preferred order of importance by simply assigning the ranks of 1, 2, 3, . . ., n, weight generation is essentially automatic.

Exponential weighting coupled with a data structuring scheme which utilizes pointers enables the procedure to function by quantifying, ordering, weighting, and calculating the match score for each of a set of entities. Two pointer vectors, ORDER and STRATA are utilized by the procedure. An illustration of ORDER, which contains the attribute item numbers in their sequence of importance, is contained in Figure 2-1. Figure 2-2 illustrates STRATA, which contains the required attribute quantity or quality values.

As the various entities are screened, a match score is accumulated for each entity and is retained in a vector named RESULT. Scores are entered into this pushdown storage device by a method called ranking by insertion. The match score is merely the summation of the weights of attributes whose quantity (or quality) meet or exceed the user's requirements. Figure 2-3 diagrams the operation of the pushdown scheme. Figure 2-4 illustrates the before and after contents of RESULT when the match score (85.67) for a new entity has been summed and entered.

Possible output from the procedure is shown in Table II-1. Operation in this case was related to industrial site selection. The ten sites having the best scores have been retained and displayed. As an aid to final evaluation, the identification numbers of the attributes having a higher quantity (or quality) value than required are also displayed. The same is true for those attributes failing to meet the stated needs.

This procedure could be adapted to be a part of ARIS. A desirable feature of the scheme is its feasibility for use with remote terminals.

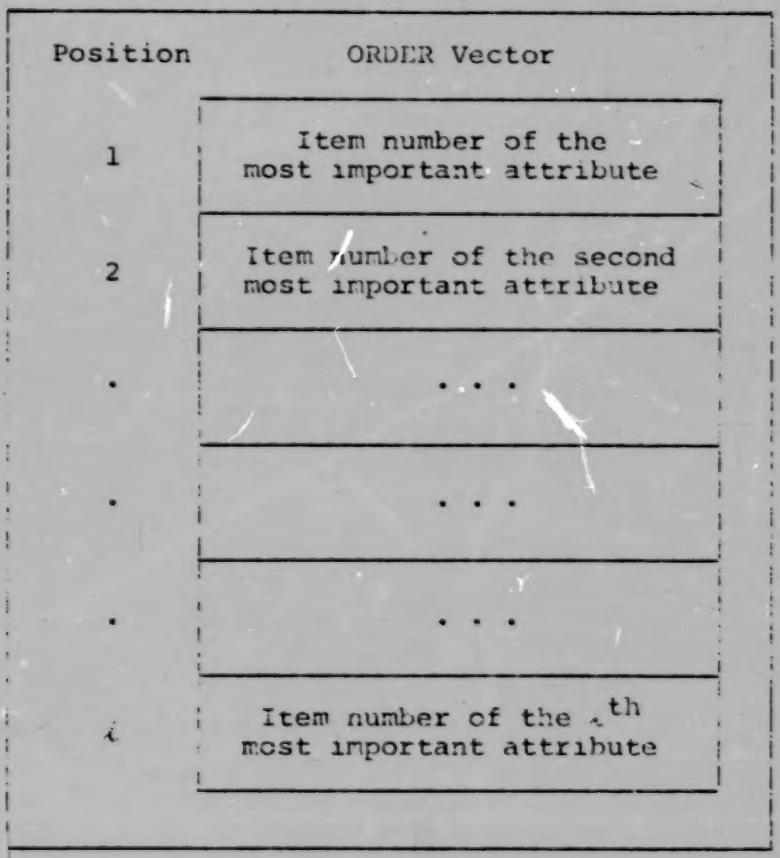


FIGURE 2-1. ORDER Retrieval Vector

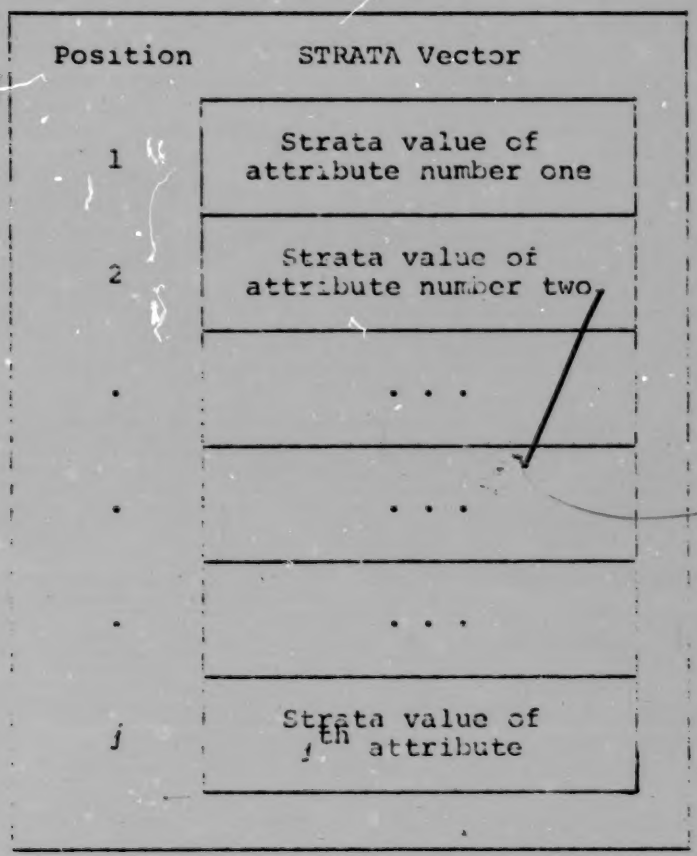


FIGURE 2-2. STRATA Retrieval Vector

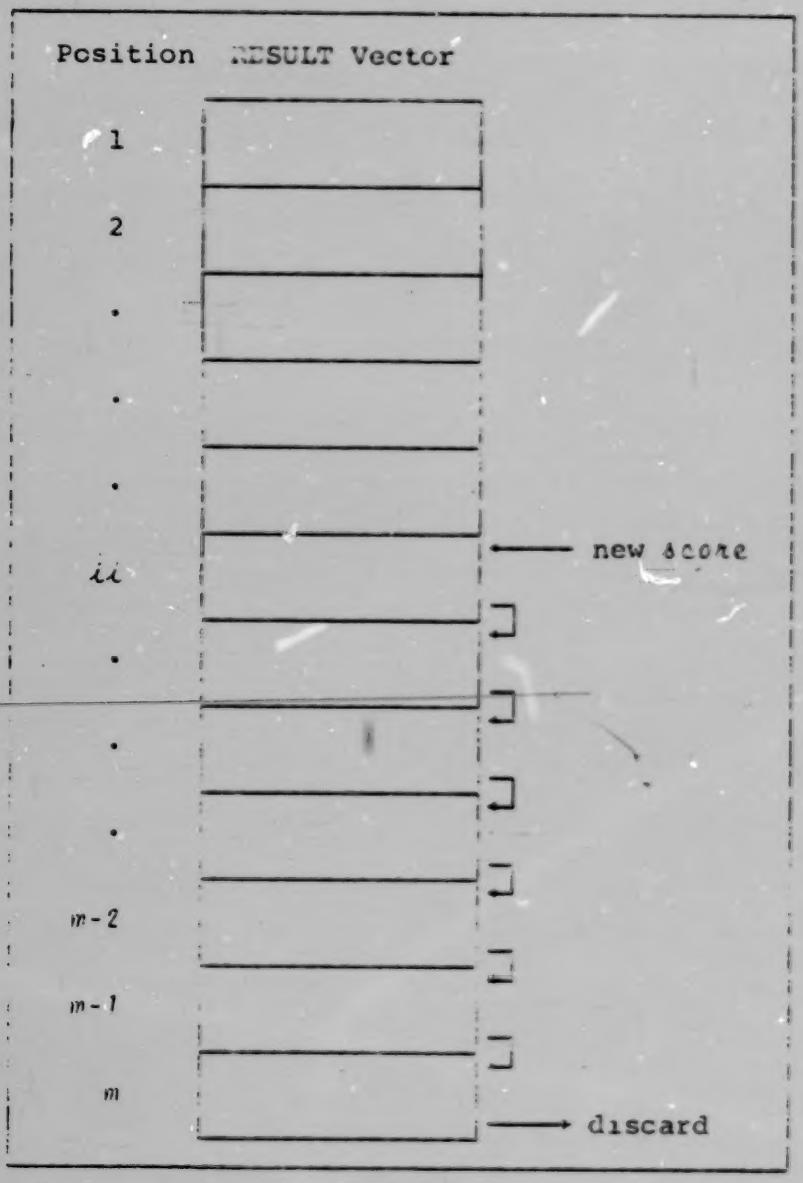


FIGURE 2-3. Pushdown Storage Operation Using RESULT Vector as an Example (activity progresses from m^{th} element to the ii^{th} element)

Position	RESULT Vector (before)	RESULT Vector (after)
1	92.75	92.75
2	91.63	91.63
3	89.85	89.85
4	87.16	87.16
5	85.64	85.67
6	83.92	85.64

FIGURE 2-4. Illustration of Pushdown Storage Operation

TABLE II-1

ILLUSTRATION OF OUTPUT FROM MODIFIED PROCEDURE

RESULTS OF SEARCH FOR LOCATION FOR ACME MANUFACTURING FILE 10.1-72A

RANK	MATCH VALUE	LOCATION	FILE NUMBER	CHARACTERISTICS VS SPECIFICATIONS Number of Instances Where Better	Poorer	UP TO TEN SPECIFIC FACTORS WHEREIN ENTITY QUALIFICATIONS Are Better	Are Poorer
1	94.66310	Mobile	305-441-737	4	2	1 19 18 16	17 20
2	94.32567	Tulsa	650- 42-103	4	2	1 19 18 17	16 20
3	92.94521	Cincinnati	243-523-695	3	3	1 19 18	16 17 20
4	82.97055	Buffalo	416-641-508	4	2	1 18 16 17	19 20
5	79.61638	Salisaw	322-306-303	4	2	1 18 17 20	19 16
6	78.82079	Atlanta	147-332-359	3	3	1 18 17	19 16 20
7	67.29079	Birmingham	557-387- 19	3	2	1 19 16	18 20
8	61.60986	Lockport	423-584-873	3	2	1 19 17	18 20
9	59.65521	Columbus	411-411- 41	3	3	19 18 16	1 17 20
10	57.23860	Stilwell	210- 31-100	2	4	19 18	1 16 17 20

Numerous computer programs are available which have been designed for specific analytical purposes. Many of these programs are highly flexible and may be modified for use in developing a resource system such as that proposed for Alabama. Some general problems are associated with evaluation of both hardware and software for the program. Some problems are as follows:

1) The volume of data which has to be handled;

2) The required response time of request;

3) The frequency of request;

4) The character of inquiries from numerous requestors - similar or dissimilar requests;

5) Number of inquiries; and

6) Distribution of those inquiries over time.

Many of the problems have not been specifically isolated and answered as they relate to the development of ARIS: however, it is assumed from those data which are known that a computer system of medium capacity and response time will be needed for a successful program.

With certain minimal needs and projected problems evident, it has been determined that those programs in Table II-2 can be used with varying degrees of success. The programs are highly variable in the forms of both input and output, but generally the output form follows that of the input. The input is normally one of four types - point, cell, polygon, line data, or some combination of the former types. The output utilizes a line printer or line plotter with some variations for combination of the two.

Some of these program packages, such as CALFORM, are available for an interactive mode of operation while others are for essentially a batch mode. Adaptation of one or more of these into ARIS is being planned for a variety of use forms.

TABLE II-2

IDENTIFICATION OF SOME

SELECTED COMPUTER PROGRAMS

Program* Source	System Identification	Program Description
Harvard University	GRID	The GRID system produces line printer maps which are generated from data grid cells. Cell data cannot be manipulated by this program.
	SYMAP	SYMAP is a more complex but flexible program which can manipulate gridded data to produce choropleth, contour, or proximal maps. Once again the line printer is the output device.
S.U.N.Y. of Buffalo	SYMVU	SYMVU utilizes a line plotting device to depict the two-dimensional surface of SYMAP in three dimensions.
State of Missouri	CALFORM	CALFORM is a program which produces outline or choropleth maps utilizing a pen or cathode ray tube (CRT) plotter. A Calcomp pen plotter is most commonly used.
University of Edinburg	GIMMS	GIMMS is a mapping program which has capability to produce maps similar to those of the Harvard programs - GRID, SYMAP, AND SYMVU.
CIA	AUTOMAP	AUTOMAP can produce maps in line or point data form. Primarily useful at the world level of evaluation and not local.
USDA	MIADS	MIADS is a grid manipulation system which employs the line printer. Output may be in a single map or with overlays.
University of Waterloo	GEOMAP	GEOMAP produces choropleth, contour, and proximal maps similar to SYMAP. It is not as flexible and cannot produce as large maps as does SYMAP. The core memory requirements are smaller however.

*The program source is based on the location of the originator of the program.

(Glossary of Acronyms on following page)

Glossary of Acronyms

AUTOMAP	Automatic Mapping System
CALFORM	Calcomp Conformant Mapping Program
CIA	Central Intelligence Agency
GEOMAP	Geographic Mapping Program
GIMMS	Geographic Information - Manipulation and Mapping System
GRID	Generalized Raster Information Display
MIADS	Map Information, Assembly and Display System
SYMAP	Synagraphic Mapping Program
SYMVU	SYMAP output viewed in 3-D
USDA	United States Department of Agriculture

The most common forms of computer mapping programs utilize either cells or polygons to encode information. The trend is toward the polygon techniques because of the freedom of manipulation of data using a many sided figure. The greatest detrimental element in using the polygon is data quality. Generaliy, it is desirable to encode only from original data. Previously manipulated data builds in error which does not improve the quality of information found in the cell.

Cells are generally variable in size - townships, sections, kilometers, hectometers, decameters, degrees, minutes, seconds, or others - and shapes - square, rectangle, hexagon, or others. The use of the Universal Transverse Mercator grid in many areas of the United States and the world makes it desirable to use the square kilometer as the basic cell unit. This grid system also covers the world with minimal overlap of cells and with easy identification of all world areas. Alabama is fortunate to lie within a single Universal Transverse Mercator zone.

The quality of Alabama's data will probably contribute greatly to the selection of encoding technique. It is hopeful that an examination of both the CALFORM, a polygon method, and SYMAP, a gridded cell technique, will be examined for feasibility along with the SYMVU. The three computer programs

may be hybridized for more effective presentation of ARIS. Examples of all three techniques are contained within Figures 2-5, 2-6, and 2-7. The three-dimensional SYMVU program with overlays could be very effective or SYMVU with CALFORM plots in the cells could also become a flexible and desirable mapping program.

Population change can also be depicted utilizing the SYMVU techniques (Figure 2-8). Similar methodology can be utilized to depict other changes in space over given time periods. Such information, dynamic as it is, can be very impressive when properly oriented to seeking market areas.

Limitations in the development of a program will be primarily in areas of data quality, computer capacity, and economic considerations. One of the preceding elements will interface with the others to restrain the development of the ultimate resource information system. However, a viable sysetm will emerge which can be modified from time to time to suit the needs of the State of Alabama. Refinement on a continuing basis would lead to a program which users would seek out for their varied purposes.

Appendix II contains a listing of the various software packages which have been obtained for evaluation for possible inclusion in ARIS.

REFERENCES

1. Pencker, Thomas K., Computer Cartography, Association of American Geographers, Washington, D.C., 1972.

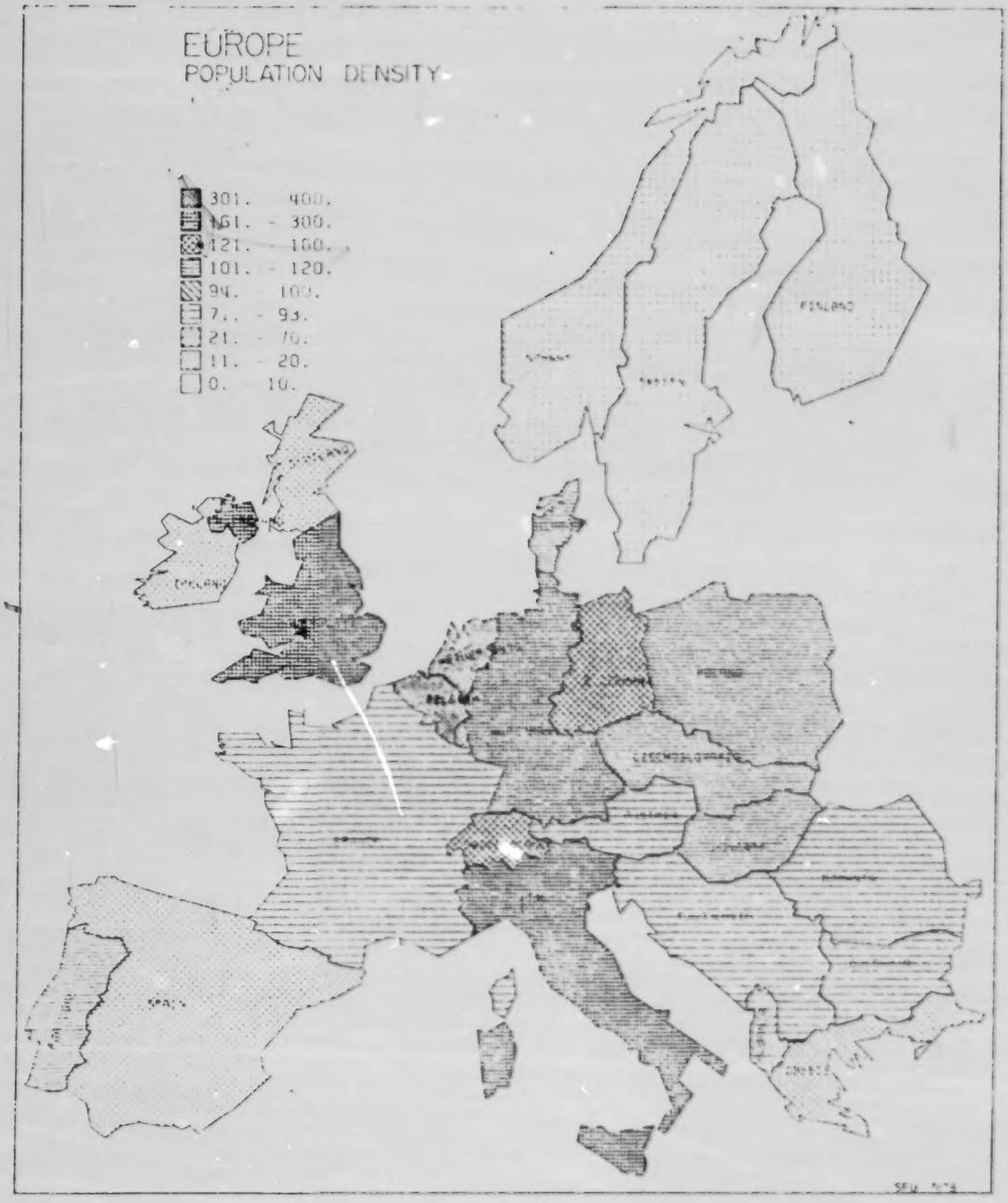


FIGURE 2-5. A CALFORM EXAMPLE OF POPULATION DISTRIBUTION. (1)

FIGURE 2-6. A COMBINATION SYMVU, SYMAP EXAMPLE. (1)

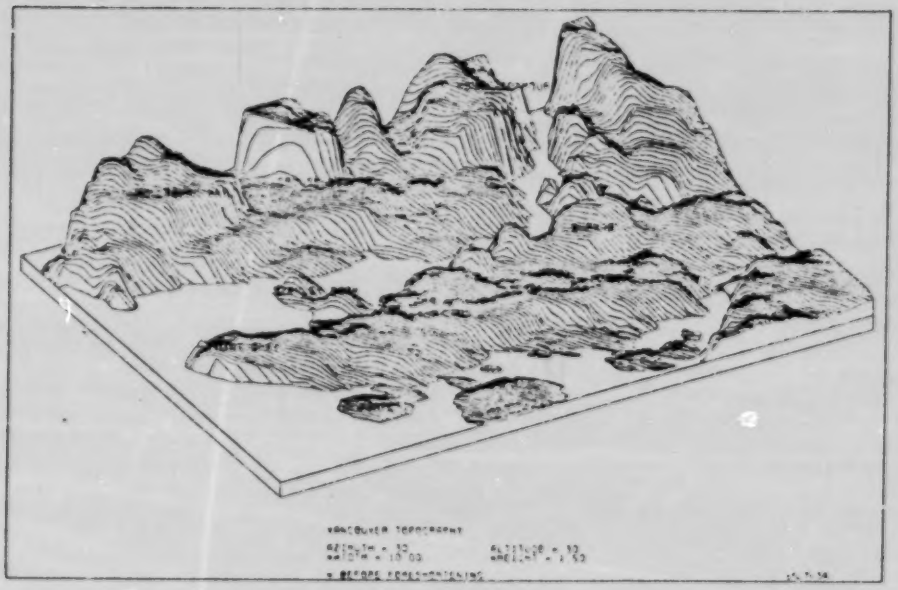


FIGURE 2-6. A COMBINATION SYMVU, SYMAP EXAMPLE. (1)

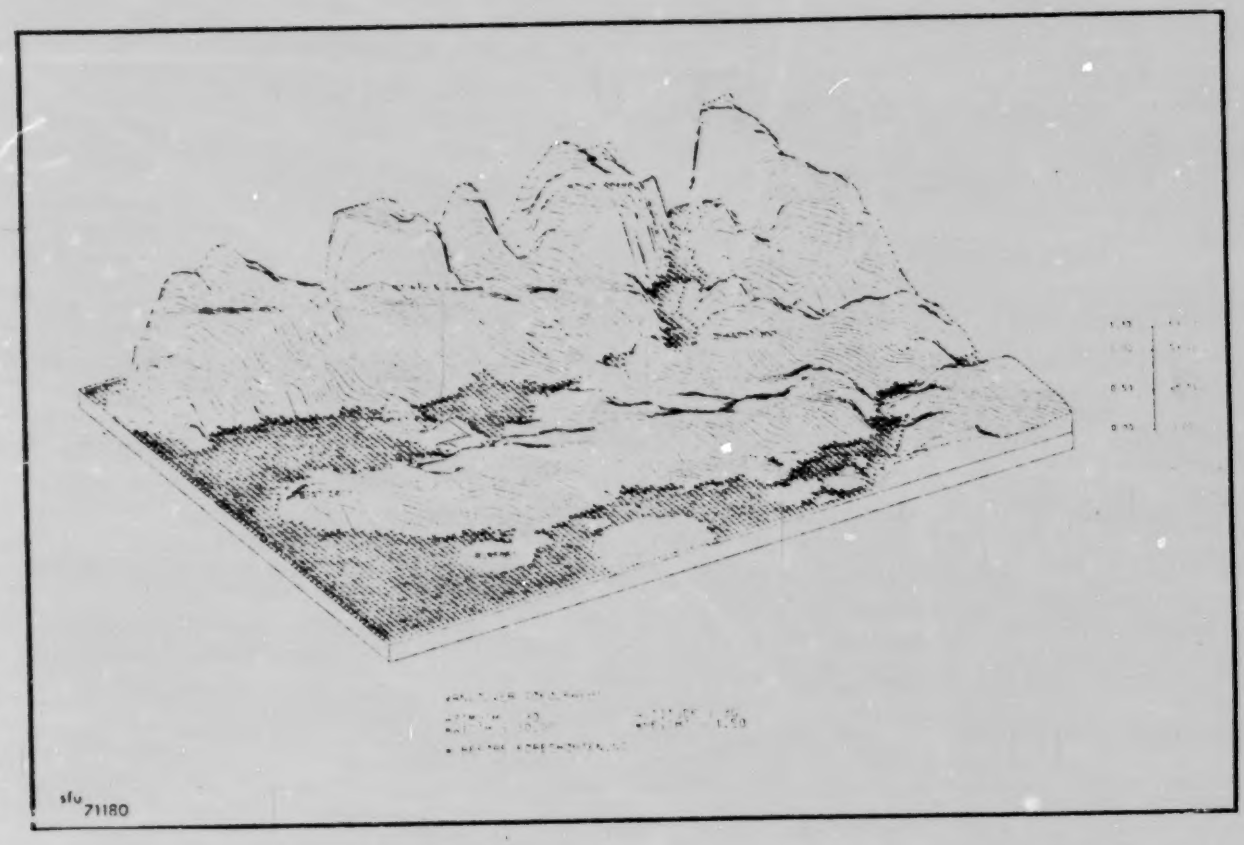


FIGURE 2-7. A SYMUV EXAMPLE OF SURFACE FEATURES IN VANCOUVER, B.C. (1)

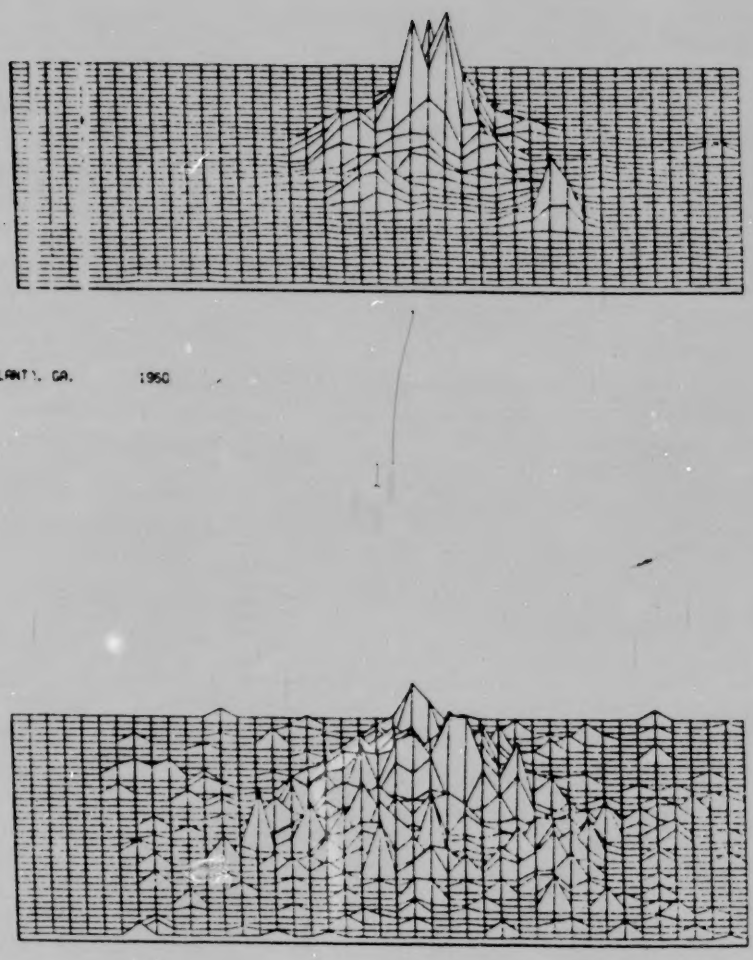


FIGURE 2-8. A SYMUV EXAMPLE OF CHANGING POPULATION DISTRIBUTION.
(Courtesy of Oak Ridge National Laboratories)

CHAPTER III. SOURCES OF DATA

The land-use resource base of Alabama must include all forms of data which are available in order that an acceptable computer program model be developed. The model will be tested in two dissimilar areas of the state that will be selected from four groups of counties in Figure 3-1. Tentative selection of the Mobile County area of the south Alabama coastal plain has been chosen as the first site. This county has diverse land-use characteristics - agricultural, forests, wet-lands, urban, and sub-urban conditions - suitable for the ARIS program. The second site will be in the Sumter County area of the Black Belt of West Central Alabama where land-use is considerably different than in Mobile County. The Montgomery and Madison County areas are alternative sites in which the model may be tested.

The alternative sites are necessary in order to facilitate model testing should either of the primary sites fail to generate suitable quantities of high quality data. All resource information, both physical and cultural, will be acquired, as possible, from all public and private agencies. Data will vary from tabular statistics to graphics and will be at various scales which will have to be corrected to conform to our encoding system by manual or mechanical techniques.

Data for the ARIS project will be derived from numerous federal, state, and local agencies. The information will come from these agencies in many forms - tabular statistics, maps, graphs, computer tapes, and photographs. The most common suppliers will be several federal agencies that generate a

FIGURE 3-1. THE PRIMARY AND SECONDARY TEST SITE FOR THE ARIS PROJECT.

great variety of information (TABLE III-1). The Alabama Development Office, the Highway Department of Alabama, the Geological Survey of Alabama, and the Regional Planning & Development Commission will be the principals for supplying State level data. Local county governments in conjunction with the Alabama Department of Revenue are expected to supply information related to the land re-evaluation and tax structures, as it becomes available.

Numerous data have already been placed on order from the several agencies. A summary of acquired data is contained in Appendix III. Topographic maps at all scales available, geologic maps and publications, soil surveys, aerial photographs, land-ownership maps for selected counties, and all Bureau of Census tapes and publications have already begun to arrive. The information is being catalogued and classified for evaluation and interpretation prior to encoding for the computer. The ARIS project is not to generate any original data. The quality of some information which is available is questionable because of its aggregate form. Other data suffer with problems of antiquity.

Two basic forms of making data available for encoding to the computer exist. One is the grid system and the other is digital. Digital techniques would be most desirable for use with original data and is a well trained digitizer was available. Two-dimensional line forms can be transformed into three dimensions for computer storage by using digital techniques (Figure 3-2). A CRT scanner would eliminate the mechanics of gridding data before encoding.

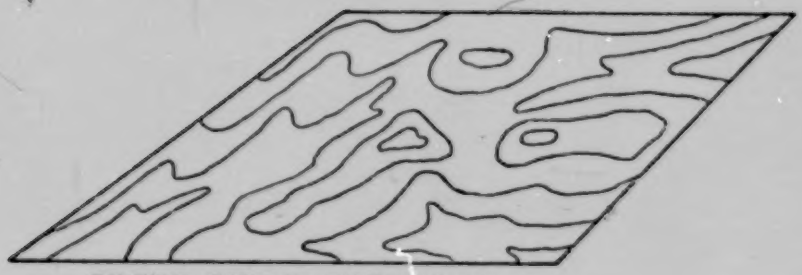
The kilometer grid of the Universal Transverse Mercator may also be used with the grid technique of encoding. Hopefully, the ARIS program will have capability to change scales from the basic kilometer unit to the smaller units of hectometer and the decometer. The smallest unit would only be used

TABLE III-1

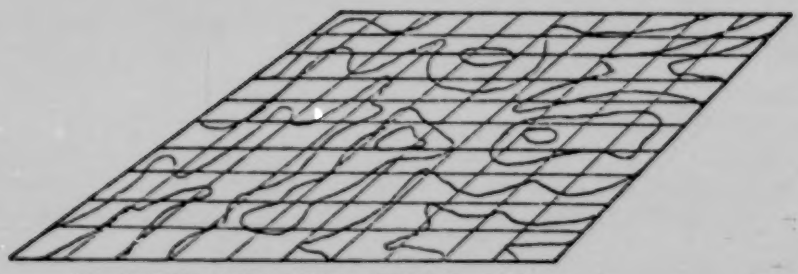
FEDERAL SUPPLIERS

OF DATA

Agency	Data Identification
Dept. of Agriculture	Agricultural statistics, forest statistics and maps, aerial photographs, & soil maps.
Dept. of Commerce	Bureau of Census statistics on business, housing, manufacturing, population, and trade (county level).
Dept. of the Interior	Topographic maps, geologic maps, water resource publications, mineral statistics, and government land information.
Corps of Engineers	Water navigation information.
National Aeronautics and Space Administration	Remote sensing data

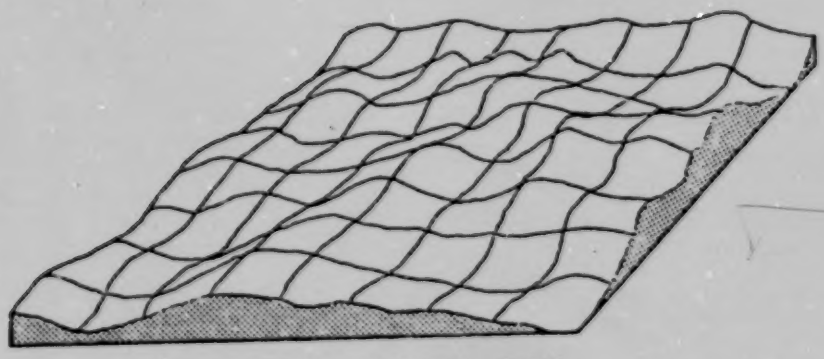


CONTOUR DATA IN DIGITAL FORM



10-METER GRID OVER CONTOUR DATA

COMPUTE MOST PROBABLE ELEVATION FOR
EACH GRID INTERSECTION.



TERRAIN MODEL IN DIGITAL FORM

FIGURE 3-2. TERRAIN MODEL GENERATION

in identifying land-use in urban or special areas. Each cell in the grid would interact with every other cell in order to fully manipulate available data.

CHAPTER IV. SYSTEM OUTPUT AND USER INTERACTION

The ARIS data base will be evolutionary in nature, expanding in response to increased user need. The proposed management structure and management functions incorporate the mechanisms to permit useful service expansion.

Initial system capability is intended to access present land use patterns interfacing both physical and cultural features of the landscape. Prototype system operation will be limited to a single test area. Appendix IV enumerates those data resource classifications which will be available for manipulation and display. Output display is to be by graphic and/or tabular means.

The design of an information management system for earth resources must consider the utilization of data and information from a wide variety of sources. In addition to the aircraft and satellite remote sensing programs (ERTS A and B, Skylab, etc.), numerous federal and state agencies have resource-related programs serving the public. At the federal level, the agencies include the Departments of Agriculture, Commerce, Interior, Transportation, and the Corps of Engineers. To support these services, each agency has developed an organization to collect and analyze data, and to distribute the information product. Table IV-1 lists some of the national level sources of potentially useful data. Likewise, each state has established agencies for collecting and analyzing certain earth resources data and for distributing the information through prescribed channels. To a lesser degree, counties and municipalities also generate

TABLE IV-1

NATIONAL SOURCES OF EARTH RESOURCE DATA

NOTE: BRACKETS INDICATE CO-LOCATED CENTERS.

ATMOSPHERIC	
AERONOMY AND SPACE DATA CENTER UPPER ATMOSPHERE GEOPHYSICS WORLD DATA CENTER	NOAA, BOULDER, COLORADO
NATIONAL METEOROLOGICAL CENTER	NOAA, SUITLAND, MD.
NATIONAL WEATHER RECORDS CENTER NATIONAL CLIMATIC CENTER METEOROLOGY AND NUCLEAR RADIATION WORLD DATA CENTER	NOAA, ASHEVILLE, NORTH CAROLINA
NATIONAL AEROMETRIC DATA BANK STORAGE AND RETRIEVAL OF AIR QUALITY DATA - SAROAD	EPA, CINCINNATI, OHIO
AIR POLLUTION TECHNICAL INFORMATION CENTER	EPA, RALEIGH, N.C.
HYDROSPHERIC	
NATIONAL OCEANOGRAPHIC DATA CENTER WORLD DATA CENTER A - OCEANOGRAPHY	NOAA, WASHINGTON, D. C.
MARINE INFORMATION BRANCH - NATIONAL OCEAN SURVEY (OCEANIC AND ATMOSPHERIC SCIENTIFIC INFORMATION SYSTEM - OASIS)	NOAA, ROCKVILLE, MD.
NATIONAL WATER DATA SYSTEM (NATIONAL WATER DATA EXCHANGE) WATER RESOURCES SCIENTIFIC INFORMATION CENTER	USGS, WASHINGTON, D. C.
SYSTEM FOR TECHNICAL DATA ON WATER QUALITY--STORET	EPA, ARLINGTON, VA.
SCIENTIFIC INFORMATION PROGRAM IN EUTROPHICATION	UNIV. OF WISCONSIN, MADISON
WORLD DATA CENTER A - GLACIOLOGY	USGS, TACOMA, WASHINGTON
LITHOSPHERIC	
WORLD DATA CENTER - LONGITUDE AND LATITUDE	NAS/U. S. NAVY, WASHINGTON, D. C.
TOPOGRAPHIC DATA CENTER	CORPS OF ENGINEERS, WASHINGTON, D. C.
MAP INFORMATION OFFICE (NATIONAL CARTOGRAPHIC INFORMATION CENTER)	USGS, WASHINGTON, D. C.
(RESOURCE AND LAND INVENTORY - RALI)	USDI, WASHINGTON, D. C.
MINERAL RESOURCE EVALUATION	BUREAU OF MINES, USDI WASHINGTON, D. C.

TABLE IV-1(Cont'd)

NATIONAL EARTHQUAKE INFORMATION CENTER	NOAA, ROCKVILLE, MD.
SEISMOLOGICAL DATA CENTER GEODETIC DATA CENTER	NOAA, ASHEVILLE, N.C.
GEOMAGNETIC DATA CENTER WORLD DATA CENTER - GEOMAGNETISM	NOAA, ROCKVILLE, MD.
BIOSPHERIC	
AGRICULTURAL SCIENCES INFORMATION NETWORK (NATIONAL SOILS DATA BANK)	USDA, BELTSVILLE, MD. USDA, WASHINGTON, D. C.
INFORMATION SERVICES	CENSUS BUREAU, WASHINGTON, D. C.
INFORMATION SYSTEM AND DATA BANK	BUREAU OF LABOR STATISTICS, WASHINGTON, D.C.
MULTI-SPHERIC	
WORLD DATA CENTER - COORDINATION OFFICE	NAS, WASHINGTON, D. C.
NATIONAL ENVIRONMENTAL SATELLITE CENTER	NOAA, SUITLAND, MD.
(EROS DATA CENTER)	USDI, SIOUX FALLS, S. D.
EARTH RESOURCES RESEARCH DATA FACILITY	NASA, HOUSTON, TEXAS
ENVIRONMENTAL INFORMATION SYSTEM OFFICE	AEC, OAK RIDGE, TENN.
(ENVIRONMENTAL QUALITY INFORMATION AND PLANNING SYSTEM)	CEQ, WASHINGTON, D. C.
CENTER FOR SHORT-LIVED PHENOMENA	SMITHSONIAN INSTITUTION, WASHINGTON, D. C.
ENVIRONMENTAL DATA SERVICE (ENVIRONMENTAL DATA INDEX - ENDEX)	NOAA, ROCKVILLE, MD.

Key to Abbreviations

NOAA - National Oceanic and Atmospheric Administration
EPA - Environmental Protection Agency
UNESCO - United Nations Educational, Scientific and Cultural Organization
USGS - United States Geological Survey
NAS - National Academy of Sciences
USDI - United States Department of the Interior
USDA - United States Department of Agriculture
NASA - National Aeronautics and Space Administration
AEC - Atomic Energy Commission
CEQ - Council for Environmental Quality

relevant data and information on earth resources. Thus the potentially available amount of data and information is enormous, especially when one considers the "dusty files" containing pertinent information that presently does not enter into information transfer channels. In addition, there are many properties of the resource data which present great problems to a comprehensive information management system -- size, diversity of form, content and rate of generation, and difficulties of access.

Overall system design criteria emphasize the importance of strong user orientation. Accordingly, the examination of the requirements for sources should begin with user needs and work back. Figure 4-1, as read from right to left, shows that user problems or needs translate into a desire for some "data-information product" which he can apply to the resolution of that problem or need. (At this point it might do well to emphasize that the distinction between data and information can best be drawn by the user and not by the "supplier.") Note that the translation from need to information product desire may not be obvious and explicit. Therefore an important task for the supplier is to aid the potential user in articulating his data and information needs. By providing an information product, the supplier has effected information transfer. More properly, information transfer really takes place only when a user is able to effectively apply the information product provided to his problem.

For the supplier, the task of creating the proper information product is one of information transformation. That is, the supplier marshals and blends available and specifically generated data and information with an eye on user needs, incorporating feedback where appropriate. In many cases the end products are generic and so serve the needs of a number of users.

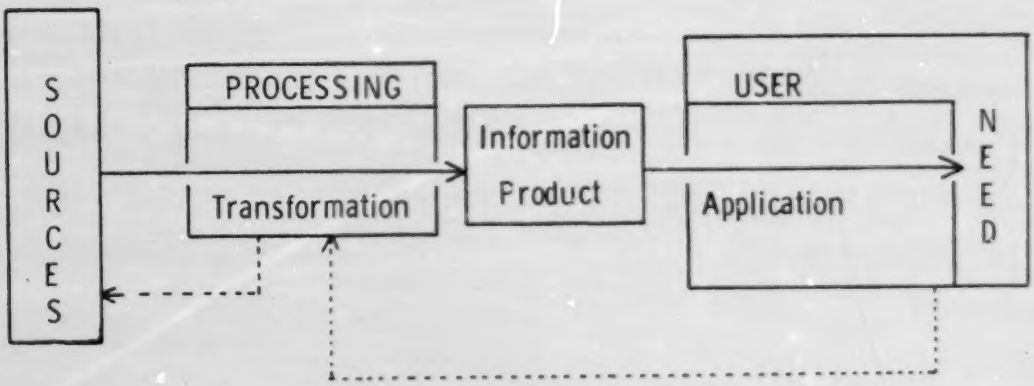


FIGURE 4-1. INFORMATION FLOW SCHEME -- SOURCE TO USER.

At other times the product will be tailored to the specific needs of one user.

What must a supplier know about data and information sources so that he can "marshal and blend" them? First he must know what is to be included in the sets of sources pertinent to his customers. That is, he must have definitions. To be efficient in his transformation efforts he must have classifications of those sources. (Classification of user needs and application is similarly important to information transfer.)

The criteria for selection of classification schemes can be expressed as follows: (a) orthogonality (classes which are fundamentally different from each other or mutually exclusive) and (b) hierarchiacal (i.e., logical, nested subdivision sequences). Figure 4-2 is shown to provide an illustration of the possible subdivision of selected source classification factors.

Coincidental with the need for some data-information product, is the need for timely acquisition of that product in a form for beneficial use. The opposite of this ideal resultant was well stated by Arlene Hershman (1): "A major cause of frustration is the uselessness of much computerized information. Overdetailed records are spewed forth by 600-line-a-minute print-out machines, inundating management with all the information it does not need to make a decision." The user of many systems know very well that the key to their immediate problem solution may be smirking somewhere in the most recently delivered pile of paper and he can't find it.

One solution to the potential problem of overdetailed records is the provision for diversity of output form. Figure 4-3 illustrates a simplified diagram of data to information flow from the source to the user. This diagram assumes system linkage to external data bases along with a unidirectional

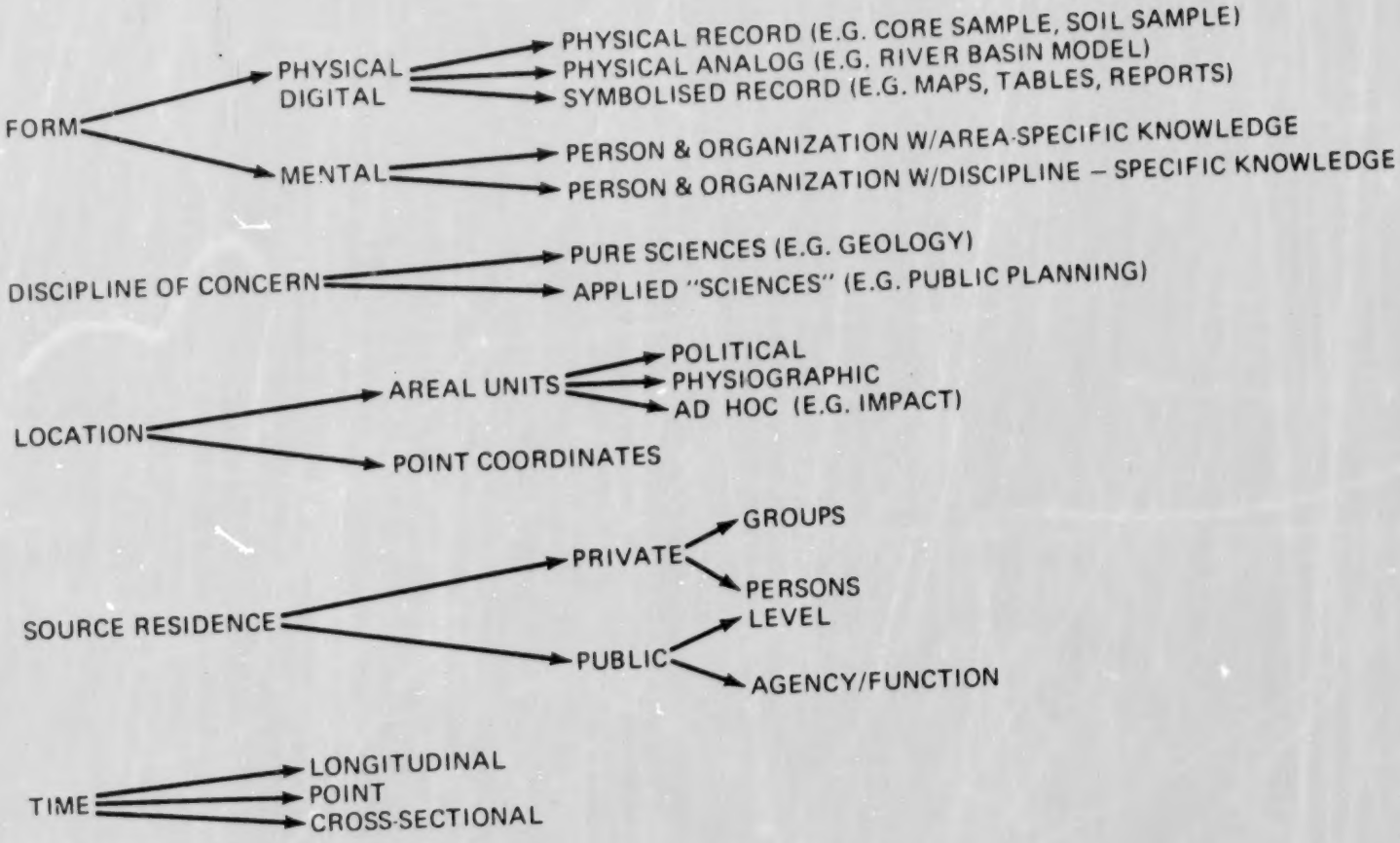


FIGURE 4-2. SUBDIVISION OF SELECTED SOURCE CLASSIFICATION FACTORS.

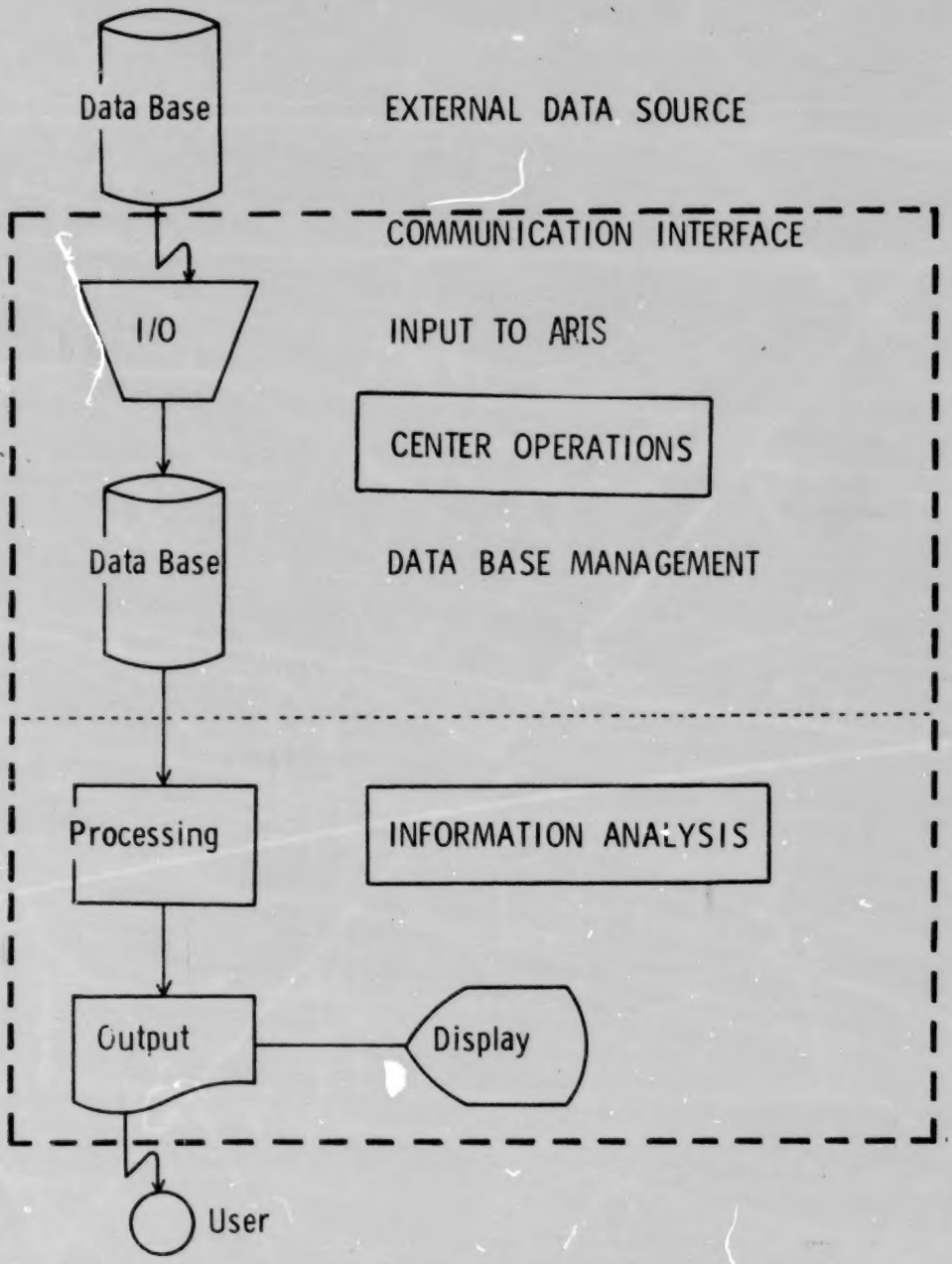


FIGURE 4-3. ARIS INFORMATION FLOW SCHEMATIC.

flow to the user. The latter aspect promotes piles of overdetailed output. ARIS is intended to utilize user initiation to trigger information withdrawal. Overt user action must also define the detail, volume, and form of the resultant information.

Figure 4-4 illustrates a sample of the user activation of ARIS. A request for an information product can be submitted by a mailed form, a hand-carried form, a telephoned message, or by use of an interactive, remote terminal. The information request, specifying both need and output form, starts the processing activity. Output documents may simply be a short tabular answer, tables of comparisons, maps, or graphs. Table II-1 and Figures 4-5 and 4-6 respectively illustrate a summarized tabulation, a three dimensional map and a three dimensional graph. Variations on these are possible. Other possible output forms are a telephoned answer, machine readable material suitable for further specialized processing, and displays on a terminal. Options for the latter include brief answers, graphs and map portions. Combinations such as a telephoned answer followed by hard copy are also feasible.

REFERENCES

1. Hershman, Arlene, "A Mess in MIS?", Dun's Review, January, 1968.

2. Durfee, R. C., "The Use of Factor and Cluster Analysis in Regional Modeling," Oak Ridge National Laboratory, ORNL-TM-3720, 1972.

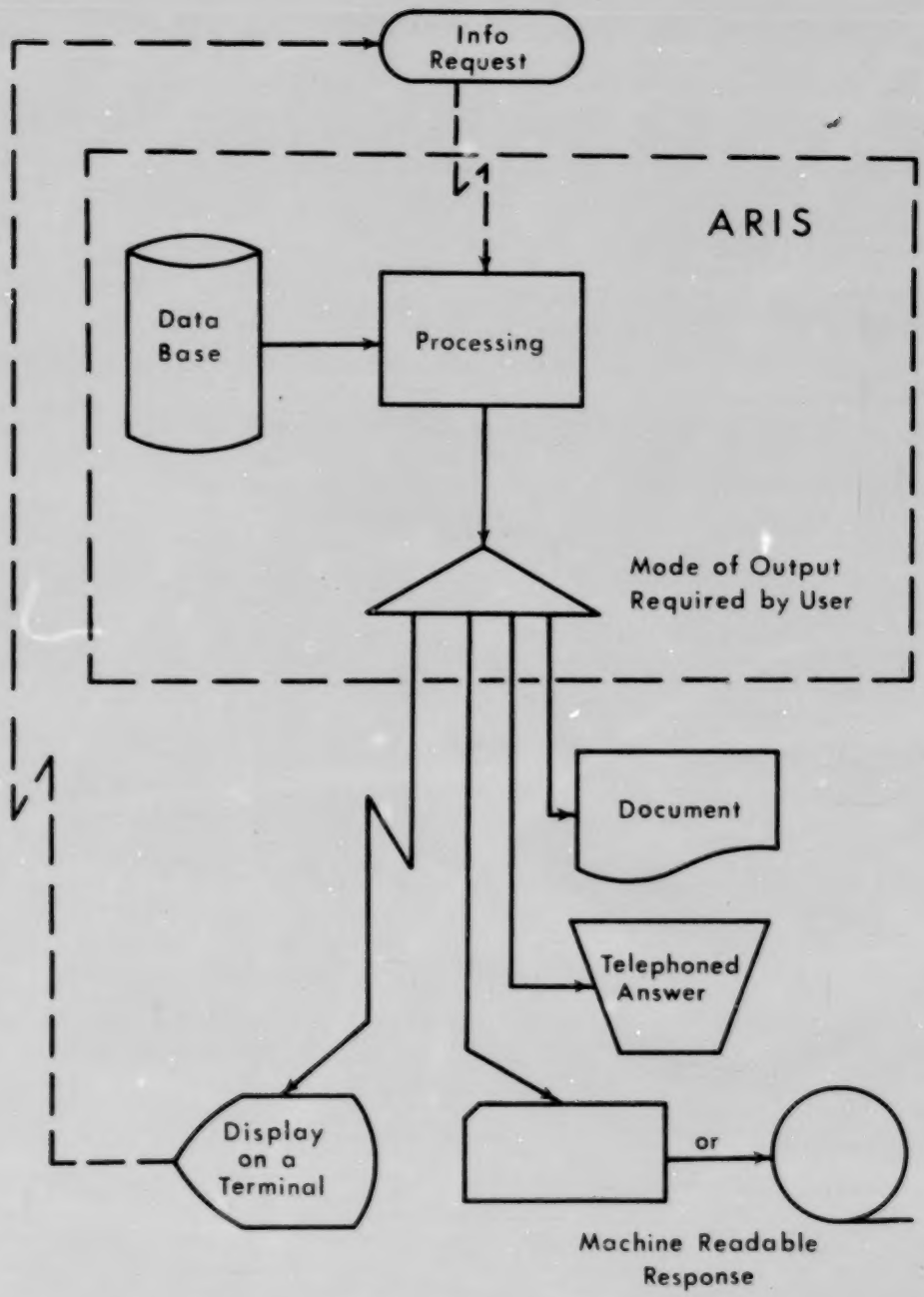


Figure 4-4. ARIS User Interaction

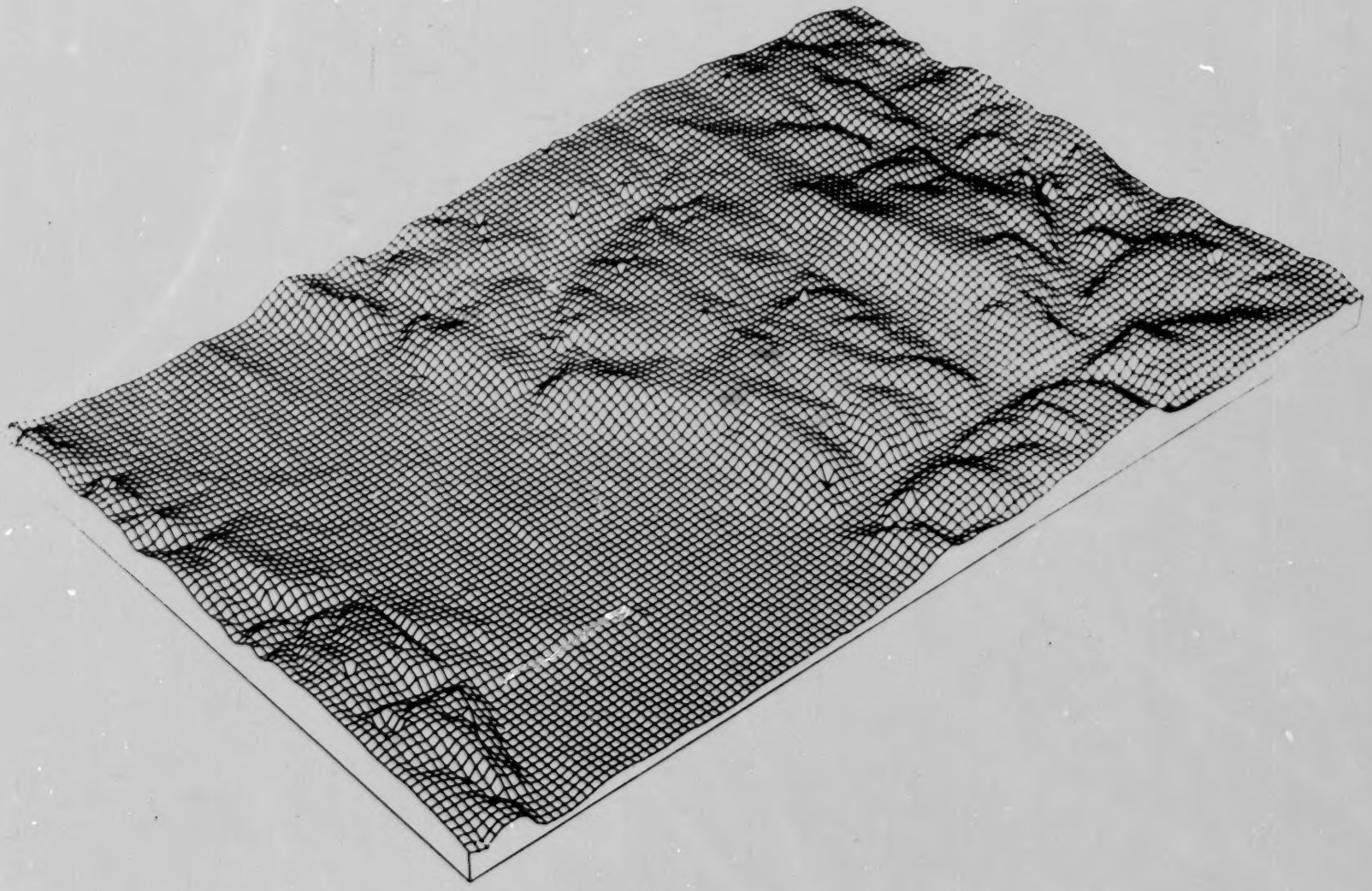


FIGURE 4-5. SAMPLE THREE-DIMENSIONAL MAP PLOT (2).

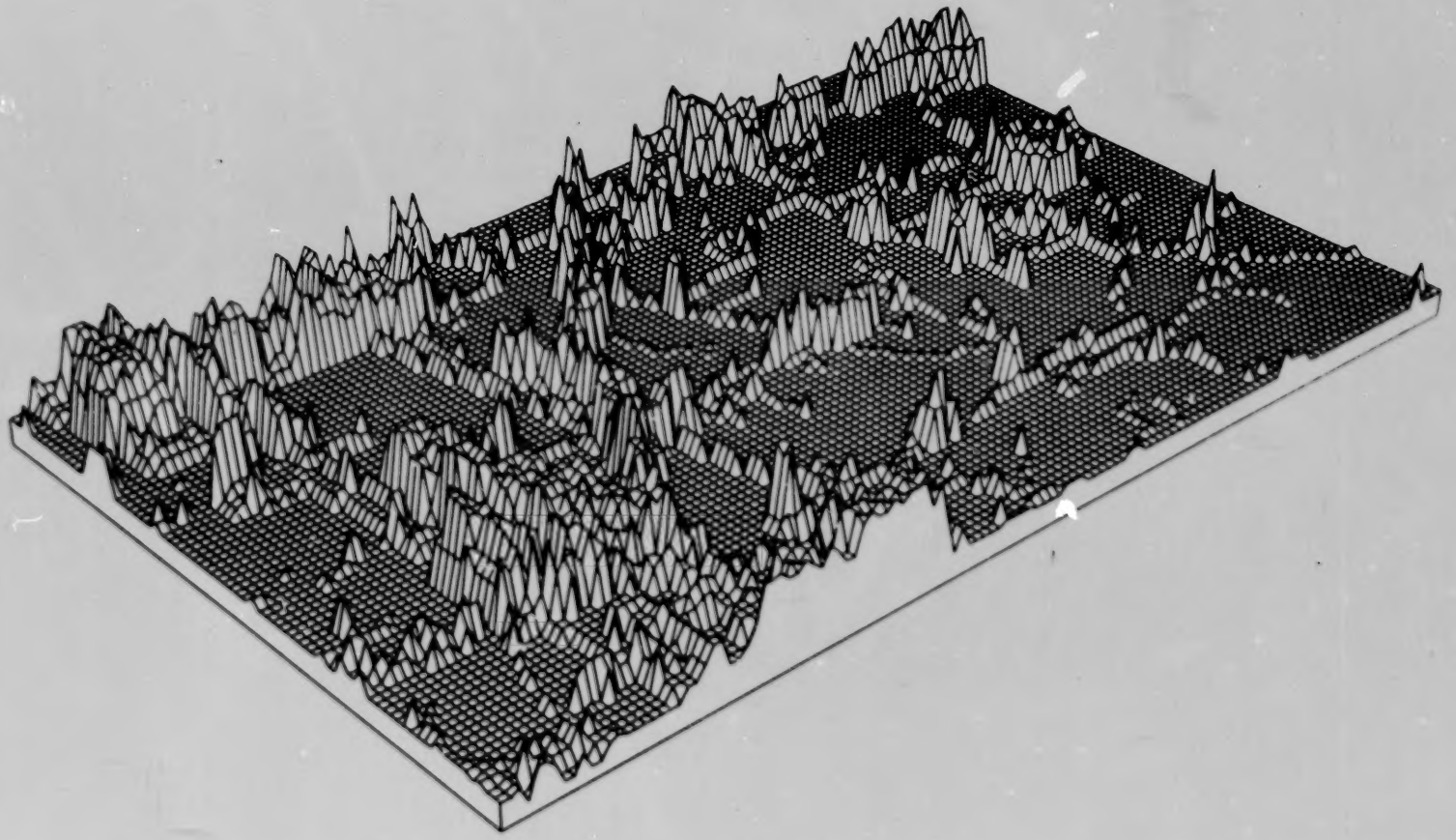


FIGURE 4-6. SAMPLE OF POSSIBLE THREE-DIMENSIONAL GRAPHING (2).

CHAPTER V. ARIS PROCESSING PROCEDURE AND PROGRAMS

This chapter contains a discussion of the detailed design criteria to be considered in the ARIS programs and procedures. Previous chapters have detailed samples of necessary data base content and the forms of desirable output. Other imposed constraints relate to a high level of required user ease and satisfaction. An additional constraint is the expected lack of computer knowledge on the part of the average user. All of these aspects point to a system of relatively extreme complexity.

Subsequent portions of this chapter detail the functional requirements of the processing procedure. These aid in both designing the proposed system and judging the potential effectiveness of that design. The extreme complexity demands sequential division into major components, their individual design, and control of the interrelationships among them.

The resulting prototype system, called ARIS I, should evolve into more sophisticated solutions. Looking toward these, ARIS II would utilize an extensive, procedure writing, resident operating system as opposed to a primary procedure (in ARIS I) which merely exercises infrequent system control of a set of predefined special purpose subprocedures. A final evolutionary stage would contain an adjunct to the system which would permit planners to investigate alternative land use schemes through the use of modeling techniques.

The processing procedure of all the ARIS systems in this chapter is based on a computer oriented information retrieval system. This processing procedure has an objective of supplying the ARIS user with the

information to meet his needs. But supplying the ARIS user with this information is not the total criteria by which the ARIS system may be measured. Listed below are several more criteria that the reader may need to examine the usefulness of the ARIS processing procedure and programs. They were developed by Cleverdon in 1964 and are as follows:

Recall and Precision - The ARIS user will have one fundamental requirement. He will expect the ARIS processing system to provide him with all or almost all of the information concerning his inquiry. Concerning this requirement, he is interested in the system's ability to fulfill two criteria. First, can ARIS recall all of the relevant data related to his information need? Second, is the data that ARIS retrieves relevant to the task then under consideration? A system that does not provide complete answers or that produces too many answers for the user to study will be useless.

User Effort - This concerns the amount of time and effort the user must put forth to ensure that his retrieval fits the recall and precision requirements. The development of an easy to use retrieval language and simple user procedures with ample instructions constitutes some of the methods employed to meet this criteria.

Response Time - There will be some deadline beyond which information received by the user will be of no value. This deadline will determine the allowable response. Depending on the type information requested, the limits of the response time may vary.

Form of System Output - Due to the wide variety of data that the ARIS system must handle, the method for outputting information to the user are extremely important. Beyond the normal tables available in most systems, ARIS must also output large quantities of graphical data.

Coverage - The ARIS system will need to cover a wide variety of information areas. If these areas cannot be covered, then the relative use of ARIS will be limited to the level of present existing information systems in the State.

To these basic criteria must be added three more standards to adequately examine the ARIS processing system as opposed to a simple information retrieval system.

Cost - ARIS processing and upkeep cost must be kept at an acceptable leval for state funding. Cost must be realistic when compared to the benefit derived from the system. One important point in terms of cost will be the system's capability to save money by preventing redundant effort in the area of data gathering.

Acceptability - ARIS must fit into the already existing structure of the State's data base. The system must adapt itself to existing procedures and data routines instead of forcing the rearrangement of the older established procedures in the State.

Generality - One objective is that the ARIS processing system be capable of implementation in a wide variety of hardware environments. This means that the computer language, as well as the physical processing equipment, must be available on a variety of manufactures' systems.

These criteria, linked with the objective of providing rapid user access to state information, will constitute the goal of ARIS. Later the proposed system will be examined in that light.

Before examining the components of the ARIS I processing procedure and programs, a general view of the concepts behind ARIS I is necessary. Most important is to remember that ARIS I must deal with user programs as well as pure data. This distinction will become clearer later in the section.

ARIS is being developed to meet the need of referencing the ever larger mass of data available about the resources surrounding men. The basic problem is that man is no longer capable of keeping up with all the information in his possession. Computers are better equipped to perform the rote task of recalling the vast index of man's knowledge. But the development of the processing system and computer programs necessary to do this task is very complicated. Attacked in an unorganized manner, the system would soon be as much a problem as the original task of correlating the data.

The planned approach is an attempt to prevent the design from becoming too complicated to be of use. In recent years a new programming concept has been developed to reduce this concern. It is known as structured programming and a related systems idea called modular programming. Structured programming is based on the subroutine idea. A large programming problem such as an information system is broken into subtasks. A brief description about each of these subtasks is written down and a programmer assigned to write a computer program subroutine that can accomplish this task. Each of these individual tasks is then brought together and an operating routine developed to form them into a system.

Many good points about the structured programming and the modular systems approach exist. A large computer programming system can be developed quickly utilizing the maximum available manpower. The system can be easily debugged (corrected) and modified because each subtask exists independently. Documentation is readily available by examining the original design subtask sheets. If project personnel are terminated, it is easy for replacements to resume the programming task where it was interrupted. Modular systems are merely large scale systems that have been divided into individual components and developed separately.

By using a modular systems approach, ARIS I expands the structured programming concept to the full processing procedure. The entire ARIS I procedure from inputting data to the final user output is divided into components and then each component is divided into subtasks. Some of these subtasks involve the creation of computer subroutines which will be stored in the system as parts of the structured program. These can be referenced by the ARIS I programming staff and users to do the necessary computer processing required in the system. The remainder of the component subtasks are of a physical nature. These involve actual material attainment of raw data, returning output to the user, and physical maintenance of the system. An outline of the ARIS I component and subtask system is available in Figure 5-1. Detailed discussion of each component follows.

The data base is the largest component module of the ARIS I processing procedure. It involves the physical acquisition of raw data and user programs. Once this information is available at the processing location, it must be transformed to some form acceptable to the remaining component modules. Finally, the data and programs must be placed in the storage devices in such a manner that the remaining system components, especially the retrieval and correlation module, can determine what information is available to the system.

Physical attainment of raw data for the ARIS data base can be divided into three methods. The first method will allow rapid input of small quantities of data that has some time limit attached to its value. Programs will accept data from terminals and allow users with special account numbers to modify and make additions to the data base. An example of this method

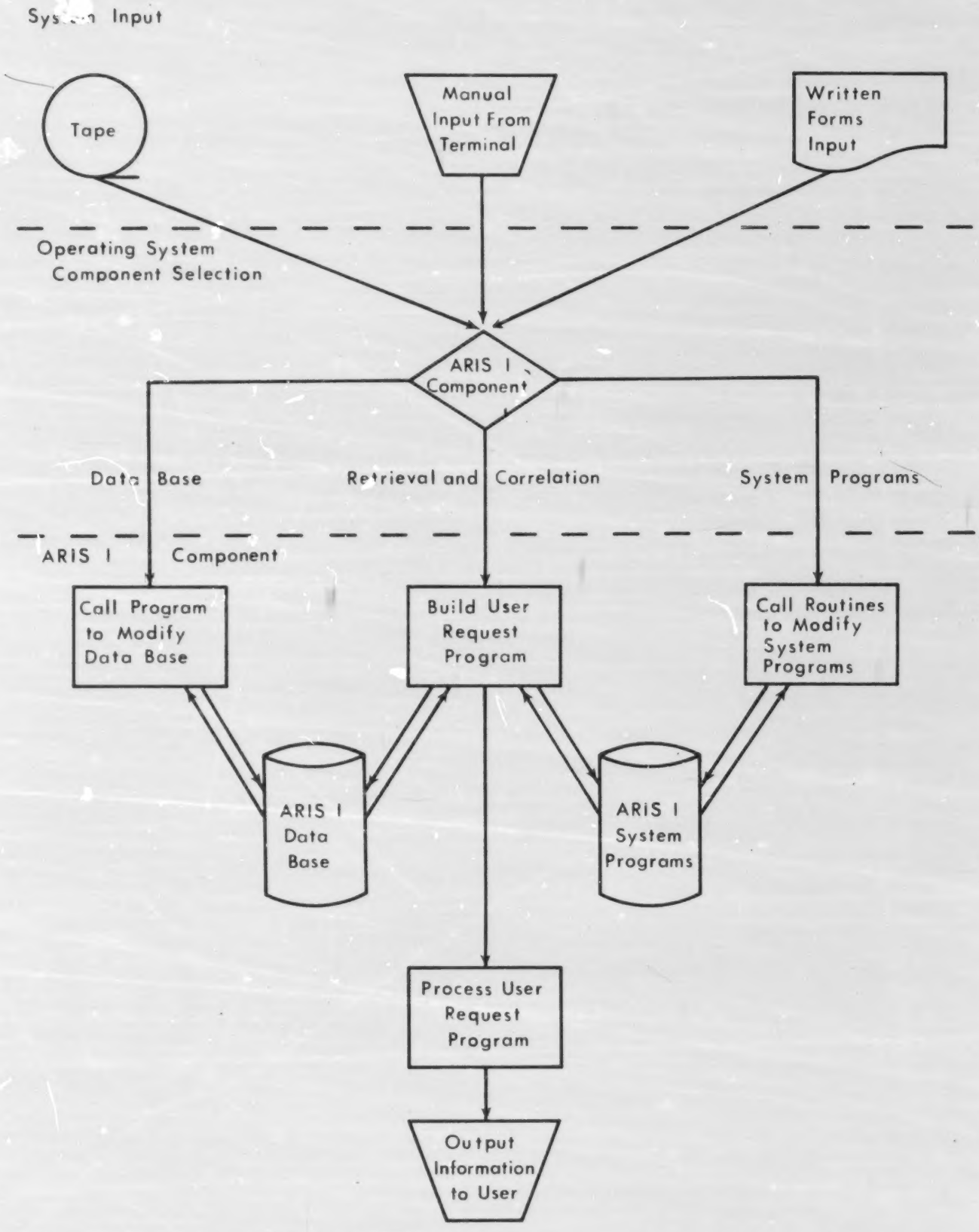


Figure 5-1 Outline of Proposed ARIS I System

and the need for it is available by examining weather data. The weather bureau would be able to update the ARIS short range weather forecast files once an hour if required.

The second form of data input to ARIS is characterized by large quantity data that is not influenced by a time deadline. Tape and computer card storage and transfer will be utilized. Tapes can be mailed to the ARIS processing center and placed in the system data base storage facilities by ARIS system personnel.

A final form of data acquisition is by written form. These forms would be made available to persons with information that could be used to update the data base. Map makers, publishers, and state planners would then mail these completed forms to the ARIS processing facilities where they would be coded onto computer punch cards and fed to the data base update programs. This method provides an inexpensive means to supply the ARIS user with the most up to date information.

The data base has been discussed without a true definition of its form or design. This has been done to let the reader understand some of the types of data that will be contained in the ARIS system. Now that this has been accomplished, a closer study of data base design can be undertaken.

One of the key attributes of the ARIS data base is the number of files being employed. Since a large amount of data in ARIS is based on some geographical coordinate system, it might be easy to use only one file keyed to all the locations in the state. But this method is not acceptable when the system must contain user programs and data not concerned with geographic locations. This led to a concept containing many files. Each file contains some information that has been acquired from a particular source. This

design allows the system to keep a master file containing a list of all data files available in the system data base. This master file would also be responsible for retaining the status, location, and keyword content of all files. Structured programs can then be developed to update and modify each file. The addition of new information sources to the system will involve creating a new file and not redesigning the entire system. It also allows for efficient storage to be employed because data that is not accessed often can be kept on secondary storage devices. The method used to integrate these files will be discussed below.

Since user programs, such as MERITS*, should be included in the system, they are also part of the data base. Each program will be stored in source form and when required, be recompiled and run. Some of these programs will be incorporated into the correlation and retrieval system module.

Once the data base has been established, some method for retrieving information desired by the user must be developed. ARIS I is more than a simple information retrieval system. It is a multiple source information management system. Data in different files will contain information with a wide variety of characteristics. This means that ARIS I must be capable of manipulating data files in order that they become similar enough to process together. For example, take the geographic coordinate systems available. One file may be based on the one kilometer grid and another on street addresses. If the system were required to search both files for characteristics that would aid in factory locations, then there would have to be some way of correlating street address and grid location. This would involve further files and programs to make the conversion. The structured programming system

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*Marshall Environmental Resources Information Transform System, Marshall Space Flight Center, Alabama

will allow this difficulty to be overcome. Programs will be developed that can convert any data item in the system to the same base as any other similar item. During a search the user can utilize such programs to create intermediate files of similar characteristics. Then retrieval programs can examine all such files to find the necessary information.

The actual retrieval will involve the user describing to the system what information he needs. In ARIS I this will be done by a program that will aid the user in building a request list for the information desired. This list will then be translated into a set of calls to subprograms that have been made available on the system. When the user finishes the search, he can choose from a wide variety of output programs. These range from a simple listing of data to involved mapping of locations within the state.

The basic language segments for the ARIS I system are as follows:

RETRIEVE (filename or program name) - This command removes a file or program from storage and prepares it for use in a system job.

SEARCH (filename, list of parameters) - Searches the file designated by filename for data items that are within limits set by the parameter list. When followed by a PUT filename command it creates a new file containing all records that pass the SEARCH command parameter list.

TRANSLATE (file 1, file 2; list of data items) - This instruction transforms data in file 1 to some base used in file 2 by the instructions in the data item list.

RUN (program name) - Executes a program labeled as program name.

CREATE (filename) - Creates a file for use by the program.

These are some of the basic instructions to be available to the ARIS I user. More instructions will be developed as they are needed. Manuals on how the system may be expanded will be made available to the user.

Figure 5-2 contains an illustration of how ARIS I could function. The user will log onto the system and inform the control program that he wishes to search the data base. He then has the option of typing in a search program that has already been developed, receiving help from ARIS I to write a search program, or running a user program available in the ARIS system. If the user wishes to write a search program, then the assistance program will aid him and then translate the retrieval language request into a more standard computer language subroutine calling sequence.

Once the remainder of the ARIS I processing procedure components are complete, then they can be brought together under one hardware device to form a system. This system must be responsible for interfacing user requests with other ARIS I components. This includes accounting and user additions to the system.

ARIS I is an evolutionary programming system. Since it would be impossible for any designer to plan for all contingencies, the first ARIS system must be capable of adapting to meet changing user requests. This "self modification" ability will be provided by a special set of systems programs. These programs will aid the systems personnel with the task of adding new capabilities to the system. For example, the addition of a new command to the retrieval language will be accomplished with the aid of a computer program.

The accounting program will be responsible for billing, retention of user statistics, and system security measures. Billing will be an easily modified section that can be established to charge for certain costs such as plotter paper. The statistics will be kept to allow planners to make ARIS I system changes to meet growing demands. Security will be used to

USER: ATTENTION

ARIS: Please type your account code.

AUBURN-74

Welcome to ARIS I. Do you need help with your retrieval request?

YES

Look at a recent listing of data files contained in ARIS and select those files with information you require. Issue search commands for data items in these files that fulfill your data requirements.

SEARCH MINERALS, COAL>20, SANDSTONE<15

SEARCH LANDUSE, ZONE='INDUSTRIAL'

SEARCH WORKFILE, LABOR>89

If any files contain data of varying bases is being used in program, then errors will occur. Please use translate commands to change all data items to the same base reference.

TRANSLATE LANDUSE, LANDUSE; COORDINATES='GRID'

Now use the create command to create a file that will contain all records from the files that have been searched and passed the parameter tests.

CREATE WORKFILE

If you wish to search this file for any further data, please program more search commands.

SEARCH WORKFILE, LANDAREA>1000, COUNTY='JEFFERSON'

Now choose an output program and run it.

RUN SYMAP

FIGURE 5-2. EXAMPLE OF POSSIBLE ARIS USER/SYSTEM INTERACTION.

prevent classified information from being stolen and to protect the data base from accidental erasure.

These are the basic components of the ARIS I processing system. Once integrated they will be the resource information system. The only question that remains is whether this design will meet the requirements of a useful information system.

As mentioned earlier, there are some criteria by which ARIS I can be judged. The first of these was recall and precision. ARIS I recall capability will depend on how extensive the data base can be maintained and whether the system can determine what is contained in this data base. Since the ARIS I data base can be expanded to any size desired, it will be capable of recalling a wide variety of data. The precision will depend on how well the user can phrase his request. The requester aid program will attempt to optimize any request in order to maintain a high level of precision. The system statistics program will be capable of informing the systems personnel if there is a trend present that indicates a need for system modifications. This can be dealt with by using system modification programs to uprate the deficient portion of the system.

The system must be simple enough to give the user confidence in its use and minimize user effort. The retrieval language is simple enough to allow use by non-programmers while still providing efficient use of ARIS I capabilities. Since the actual computer programs will already be written, the user need not spend much time on a request for information.

Requested information will hold its value for a finite length of time. Because the the user will need answers to questions quickly, the response time of the system is critical. This is where the small machine environment

of the ARIS I system does not meet criteria. The slow search time of small machines over a data base as large as the one involved with ARIS will cause a high response time. Data stored on secondary devices such as tapes will have to be made available to the system and the physical time required for this task will be a factor in the slow response time. Alogorithms will be available to speed search procedures but system response will still be slow.

ARIS II is intended to make concessions to this criteria in order to lower search time. This will permit use of on-line terminals to conduct user inquiries. In ARIS I the time lag between the user on-line request and the answer becoming available is taken care of by a mail drop system. The user informs the accounting program that he wishes his answer spooled to a data file in the system and he will call back for it later or have it mailed to him.

With the large number of output programs available to the ARIS I programmer, a wide variety of system outputs are available. For simple lists, there are user written output subroutines that generate titles as well as listing data. SYMAP is for users wishing to print graphical data such as maps on the line printer. CALFORM allows the user to plot his output on an incremental plotter. System design calls for inclusion of these and/or similar existing procedures. Tapes can be created by the system for transfer to other installations. Physical output will be available on a line printer, on plotter paper, and on a video graphical computer terminal such as the TEKTRONIX 4002A. With special supplied software routines, a user can view his output on the display screen of the terminal prior to actual printing of the information. This will increase efficiency where lengthy

plots or printouts may be in error, by allowing the user to view his information and correct it before preparation of hardcopy.

The ARIS coverage ability will be provided by the detail available in the data base. This will involve cooperation with governmental agencies to ensure that the data base includes all information needed by the user. ARIS I is expected to be capable of retaining as large a data base as required to cover any user need.

Cost is one of the most important criteria influencing ARIS I design. With the ability to operate in a small machine environment, the hardware cost for ARIS I will be at a minimum. Actual processing procedure and programs have been influenced by the cost factor. Modular systems will allow the ARIS I system to operate efficiently with a minimum of manpower while still meeting the needs of the State. Actual cost studies will have to be based on the choice of a final hardware configuration by the state planners.

The acceptability question is very difficult to answer. Since the data base has been designed to input data in the form that is prevalent at the installation it is received from, the system will not interfere with older data bases. The security accounting programs will provide a secure data arrangement. This will allow people in the State to feel safe from "big brother" using the system to examine private lives. These two factors should tend to make ARIS acceptable to both users and the ordinary citizen.

The State has a variety of physical computer systems presently available. With the choice of FORTRAN IV as the computer programming language and the structured programming approach, ARIS I could be developed on any one of several computer hardware systems. This will reduce the cost of ARIS I by reducing the expenditure for specialized hardware.

ARIS I fits the criteria within some operational limits, but does not match perfectly. This is due to the desirability of a general system at minimum cost. Once applied to one operating environment, ARIS I should become more efficient.

ARIS II

Even though ARIS I will fit the requirements of a basic resources information system, there are some future considerations planned into the system. If the State desired to expand ARIS I to several installations or become part of a nationwide information system, then ARIS I would prove to be inadequate. The expansion of ARIS I into ARIS II would involve the addition of a more sophisticated operating system. This operating system would be a core resident program that accepted all information coming into the system including user requests and created special programs to handle these segments. A more detailed error handling routine could be added to the operating system to aid in error detection. ARIS I has only limited error detecting capabilities. One particular error that ARIS II would be programmed to prevent is the detection of different data bases being used. If a user were to attempt to correlate graphic coordinate data of one kilometer grid and street address, then the operating system could detect this and warn the user that a data transformation was required.

The three basic differences between ARIS I and ARIS II are cost, generality, and user effort. The cost of ARIS II would be dependent on a more advanced processing facility. The development cost would be higher due to the increased dependency between programs in the system. The advanced operating system would allow the user more freedom and thus decrease user effort. This might promote system use by the greater portion of state planners.

ARIS II would require a more advanced computer language such as COBOL or PL/I for its source language. This would decrease the generality of the system. A tradeoff study would have to be made of the State information goals before a project such as ARIS II were undertaken.

ARIS III

Of particular interest to project personnel was an early information resources system developed at Oak Ridge. This program was oriented towards modeling resource data concerning an "ideal" county. The system modeled several key factors such as air pollution and urban land use. ARIS III is an ARIS II system with a discrete modeling capability to aid State planners to answer "what if" questions. These programs would be developed in conjunction with resource planners to aid future State needs. The ARIS III system would require as much effort as ARIS I and ARIS II combined required to develop. It should be left for some future goal in the long range resources information system plan.

CHAPTER VI. ARIS MANAGEMENT

"Managing is . . . the design or creation and maintenance of an internal environment where individuals, working together in groups, can perform efficiently and effectively toward the attainment of group goals." (1)

An enterprise which has as its goal the efficient and effective management of information must itself be efficiently and effectively managed. A prime requisite for meeting this ideal is for members of the resultant organization to be constantly mindful of their mission of service. Figure 6-1 is shown to illustrate this mission of user service.

The first step toward the conceptual design of a management structure for ARIS is to establish and define its functions. The seven functions of management of any organization are:

1. Plan
2. Organization
3. Staff
4. Direction
5. Control
6. Representation
7. Innovation

These seven functions may be subdivided into more specific functions, related to ARIS, for which management must develop policy. These are:

1. Ultimate Authority
2. Planning
3. Research
4. Public Relations
5. Marketing
6. Education

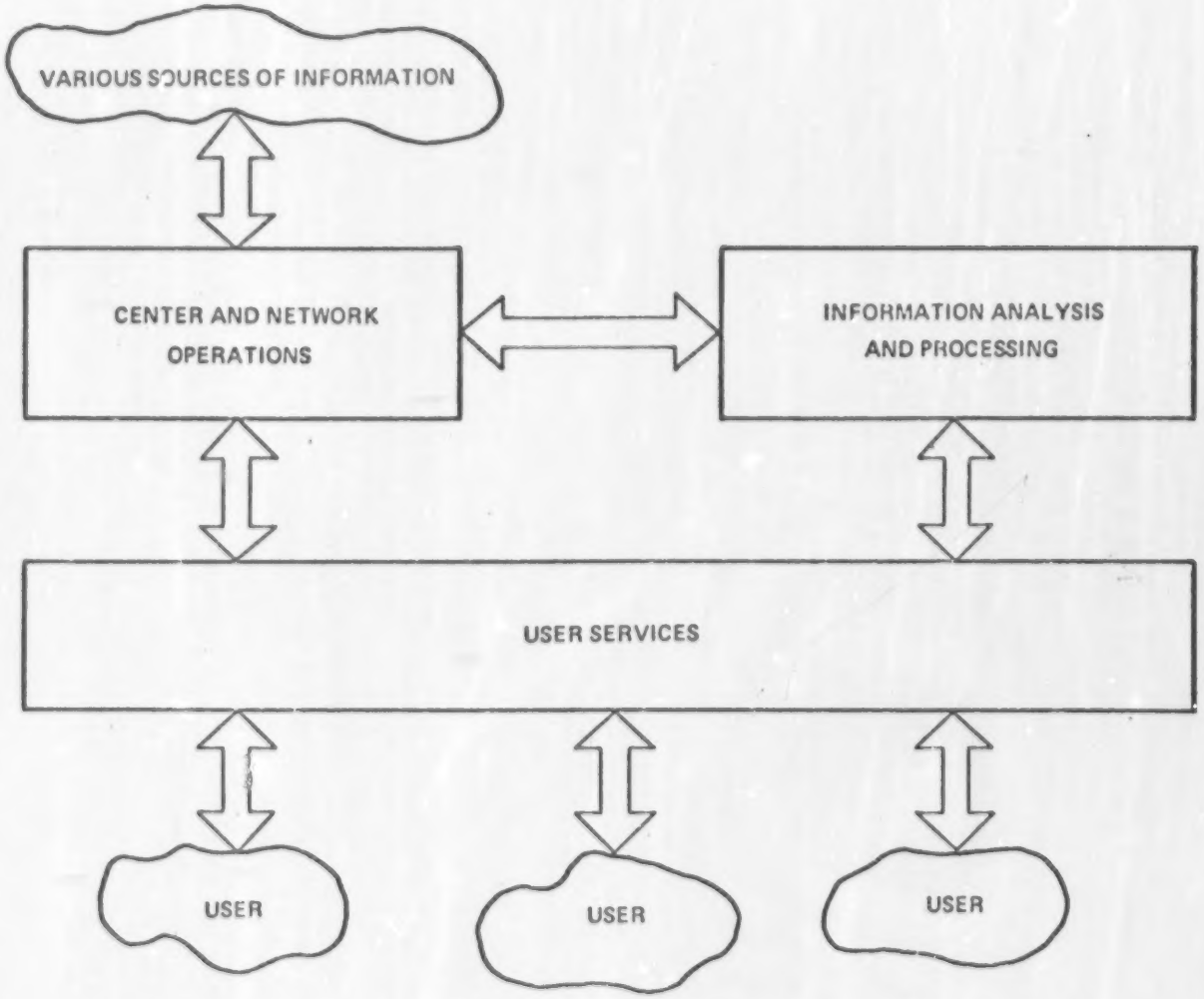

FIGURE 6-1. INFORMATION FLOW THROUGH ARIS

7. Data Analysis and Processing
8. Data and Information Maintenance
9. Equipment Maintenance and Support Services
10. Interfacing
11. Sources
12. Operational Financing
13. Personnel
14. Legal
15. Priorities
16. Security
17. Monitor
18. User Entry

Much of the remaining discussion is devoted to elaboration on the above functions and the selection of a structure to provide for efficient and effective management of the system. Criteria used in developing the proposed management structure are shown in Figure 6-2.

The several detailed functions of the ARIS management are listed and discussed in following paragraphs.

Ultimate Authority - an information center like any other human organization, must include a means to establish decision making authority, and hence must have a component which has ultimate responsibility and authority for the operation of the center. Approaches to this authority component are a single person (director, manager, president, etc.), a board of directors, or a management committee. The same component may have ultimate responsibility and authority for center policy or it may be subject to policy dictated by an activity which is administratively superior to it.

Planning - Toffler (2) states that there is a ". . . call for permanent revolution in organizational life, and more and more sophisticated managers are recognizing that in a world of accelerating change reorganization is, and must be, an ongoing process, rather than a traumatic once-in-a-lifetime affair." As a new "industry" dealing with a rapidly changing

CONSTRAINTS

Financial
Timing
Consistency with
Existing Agencies
Technology

CRITERIA

System Operation and Administration

Cost
Reliability
Duplication
Adaptability
Manageability
Monitoring Capability
Transferability
Compatibility

System Effectiveness

Political Acceptability
Interaction
User Effort
Response Time
Capability
Entry Effort
User Satisfaction (Availability,
Accessibility, Recall, Precision,
Coverage)

FIGURE 6-2. MANAGEMENT STRUCTURE SELECTION CONSTRAINTS AND CRITERIA

product and serving hazily defined, constantly changing markets, the information industry must pay careful heed to Toffler's words. An important function of ARIS is thus to examine changes, internal and external to the system and make plans to allow orderly modifications in the administration to meet real and anticipated developments in technology and changes in the market.

Research - Before administrators can administer wisely and planners can plan intelligently, information must be accumulated and reviewed. One information input to administration and planning comes from technological research. It is here that innovative solutions to new problems hopefully will arise. New hardware and software components may be developed. New analytical techniques may be perfected. The research function of ARIS includes both active design of new systems and literature searches to stay current with the products of research by others. This does not imply that ARIS should have a resources data taking (measurement) function. It does mean that ARIS can assist users in the development of specialized data taking devices/techniques either in house or by the services of a consultant such as NASA or USGS. It also means that ARIS must have the capability to research its market.

Public Relations - marketing, administration, education, and other functions of an organization are facilitated if the organization can develop and maintain a good public image. Public relations research and publications are extensive. These can be utilized to develop and implement a public relations function in ARIS.

Marketing - policies concerning such things as fees, advertising, distribution, etc. are no less important when the product is information

as they are when the product is a piece of equipment. It is management's responsibility to make provision for surveying the existing market and studying potential changes in the market. The customer (user) must be studied in the greatest possible detail so that ARIS can demonstrate how its service will be beneficial. ARIS must sell its product both to those who initiate contact with the information system and to those who are unaware of potential benefits.

Education - education must be subdivided into two sub-functions: (1) education of center personnel and (2) education of the public. The first subfunction may be satisfied by short courses, seminars, etc. It is management's responsibility to determine when employee or staff education is necessary or advisable and it is management's further responsibility to have appropriate educational efforts implemented. The second subfunction must be managed so that the general public is first educated about ARIS and then educated in the techniques of use of the system.

Data Analysis and Processing - management must insure the availability of data analysis and processing capabilities commensurate with user requests. This pertains to computer techniques as well as the more classical, precomputer methods.

Data and Information Maintenance - central to the useful operation of an information center is the maintenance of a current data base. It is a management duty to establish policy for the following: deletion of obsolete information, transfer between active and inactive storage, introduction of new information, and authority for making changes in the data base. In meeting this responsibility, the management must take into consideration the fact that the data may take many diverse forms (specimens, books, periodicals, microfiche, maps, charts, computer forms, etc.)

Equipment Maintenance and Support Services - management must see that the practical and vital support activities of ARIS function efficiently and facilitate the operation of the information center as a whole. In addition to keeping equipment running smoothly, typical activities are: custodial services, secretarial pool, mail room, graphics (cartography, drafting, photography), and duplicating and printing.

Interfacing - management must be concerned about the technological and political problems attendant to interfaces between ARIS and other information systems (both foreign and domestic). The technological problems (hard/software) related to interfacing are the easiest to manage. By far the more difficult and important aspect of interfacing is the negotiating necessary to create an interface. Interfacing with other information systems will raise significant challenges to the diplomatic abilities of the management.

Sources - responsibility must be assigned for specification of data and information necessary for the operation of ARIS. Once the specified source materials have arrived at the center, management must provide means for their incorporation in the data base.

Operational Financing - this function of ARIS management is not different from other organizations. Attention must be paid to: payrolls and other disbursements, billing and collecting, and an operating budget.

Personnel - this is a standard function of the management of any organization. Job descriptions must be written, prospective employees interviewed, screened and hired. Employee resignation, termination and retirement procedures must be established. The importance of this function cannot be over-stressed because it bears the responsibility for acquiring and keeping a qualified and satisfied staff of employees.

Legal - nearly all the other functions of management rely on legal counsel for efficient performance. A few areas to which the legal function applies are: copyright, intrastate and interstate regulation, international regulations, communications, and employee relations.

Priorities - althought it may be the goal of the information system to do everything for everyone, management must be sure that trivial problems do not unduly interfere with more important information activities of the system. The management must establish policy for apportioning center time and effort according to the importance of the problem.

Security - it is a function of management responsibility to establish policy with regard to system data security. Management has several options to choose from, among which are: no security -- all data and information is in the public domain, management determines what data security measures will be taken on what data, or information sources and users of ARIS specify the security of their data.

Monitor - system administration falters without accurate, detailed information about what is happening in the system. Plans for system changes may be inappropriate if the planner does not know what needs changing. System monitoring in this sense must therefore include MIS capabilities.

User Entry - perhaps the most important responsibility of management is to establish the means by which a user will gain access to ARIS. A high quality product will go to waste unless the user has a simple and appropriate access to it.

The next step in the development of a conceptual design of a management structure for ARIS is to trade off the alternative ways of performing the above functions under the constraints and criteria shown in Figure 6-2.

Most important controls on the design of the management structure of an information center are manageability and the avoidance of duplication of activities within the center.

The other constraints and criteria in Figure 6-2 are important to the final design of the entire system. Management must be able to guarantee that all of these controls are adhered to in day-to-day operations.

A well managed operation will contain a minimum of duplication of activities - the results of effort in one element will be made available to all other elements. Additionally, the more manageable an activity, the more cohesive the operation of the elements and the better the response to user need.

The management structure which best meets all criteria and constraints is shown in the form of an organizational function chart in Figure 6-3. Figures 6-4, 6-5, and 6-6 illustrate the more detailed functional responsibilities to be incorporated in the working entity. It is to be noted that these charts depict the required functions rather than the specific job titles. Many of the individual job responsibilities would combine two or more of the specific functions. Other functions could be covered through the use of consultants or joint appointment with other organizations.

Initial operation of a functioning ARIS is expected to be confined to the Alabama Development Office. During that period, the functional ARIS organizational element should provide for the tasks depicted in Figure 6-5.

The next stage of operational implementation would most likely involve system use by the various Regional Planning and Development Commissions. At this time at least the User Services and Education portions of the User Services element (Figure 6-6) would require staffing. Additionally, the

FIGURE 6-3. EXAMPLE ARIS FUNCTION CHART

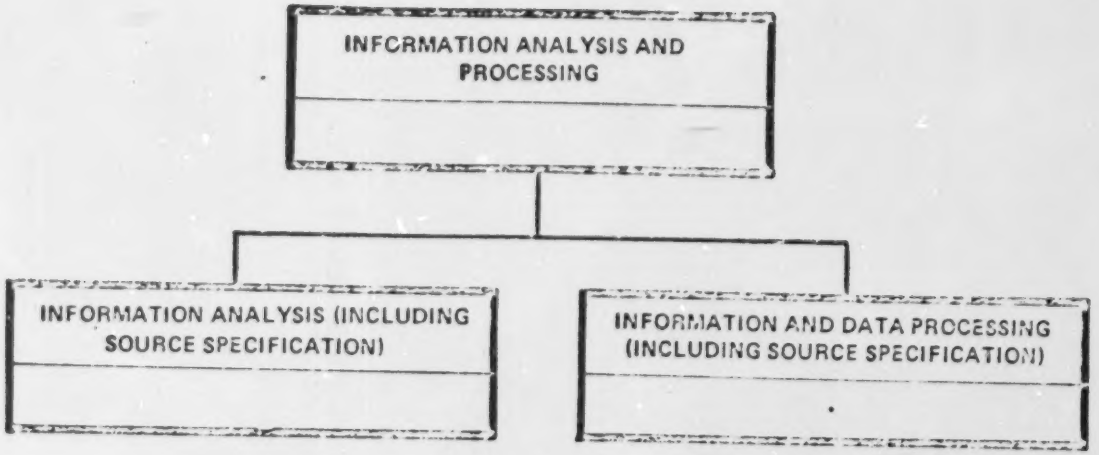
INFORMATION ANALYSIS AND PROCESSING
INFORMATION ANALYSIS (INCLUDING SOURCE SPECIFICATION)
INFORMATION AND DATA PROCESSING (INCLUDING SOURCE SPECIFICATION)

FIGURE 6-4. DETAILED CHART FOR INFORMATION ANALYSIS AND PROCESSING FUNCTION.

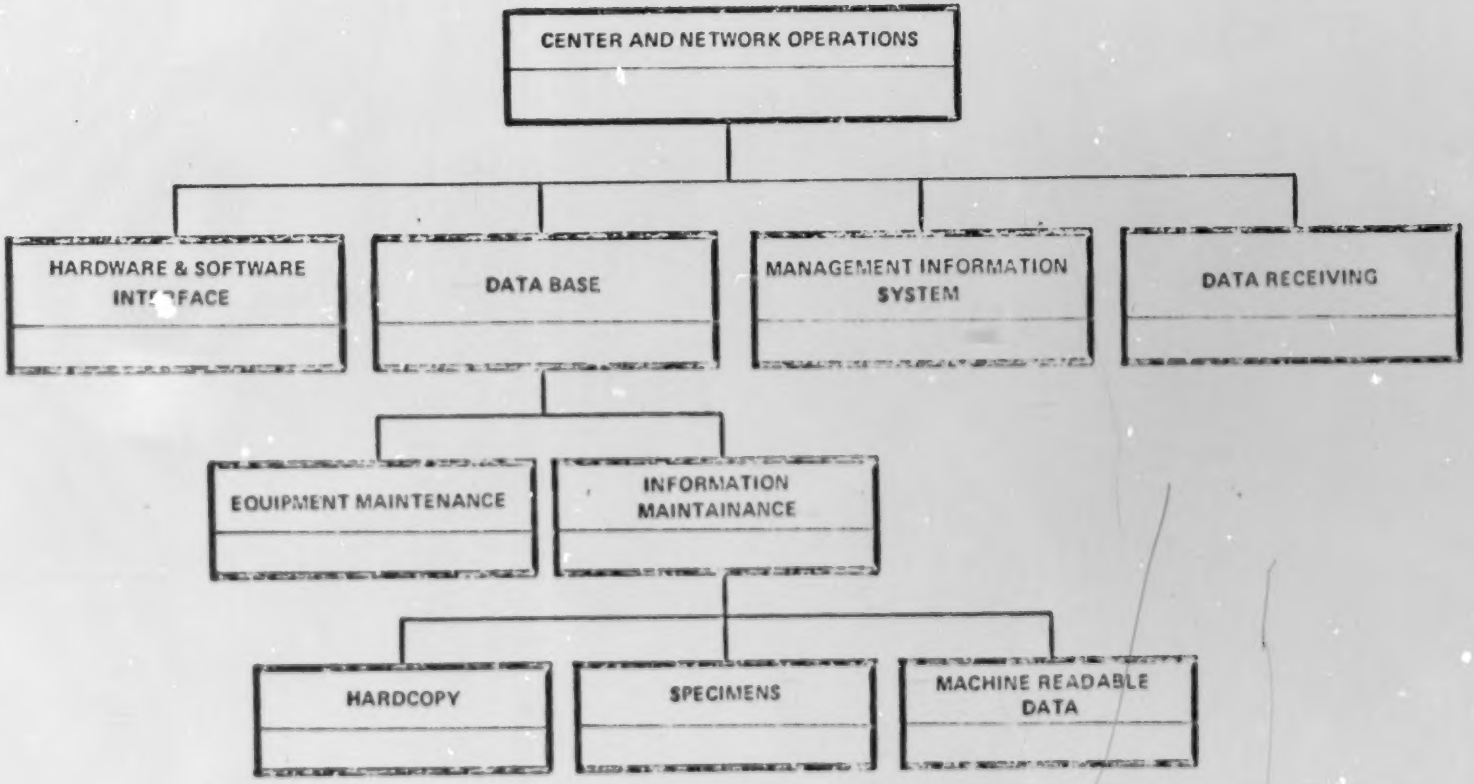

FIGURE 6-5. DETAILED CHART FOR CENTER AND NETWORK OPERATIONS FUNCTION.

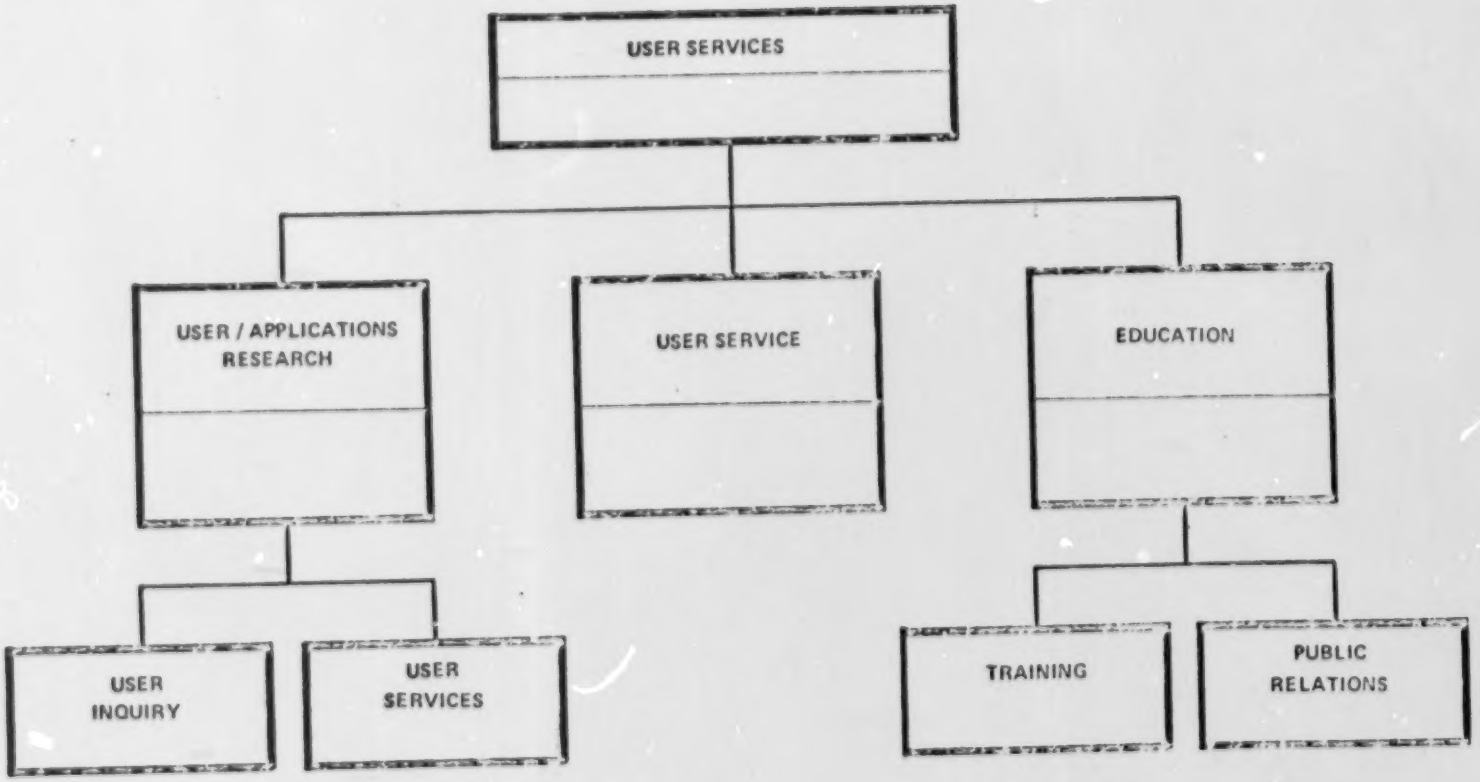

FIGURE 6-6. DETAILED CHART FOR USER SERVICES FUNCTION.

regional commissions would need to provide capability to insure the information analysis and processing function (Figure 6-4) be at a level acceptable to their needs. This could be accomplished by local staffing (in the reional commissions and municipalities) or by joint financing of personnel at a centralized location. A centralized location would provide a more efficient operation.

Until a fully operational center for servicing the information needs of all users is established, the staff functions of legal, personnel, finance, etc. should be provided within the present organizational structure of ADO.

REFERENCES

1. Koontz, Harold and O'Donnel, Cyril, Principles of Management, 4th ed., McGraw-Hill, 1968.

2. Toffler, Alvin, Future Shock, Bantam Books, 1970.

CHAPTER VII. SUMMARY

The information contained herein constitutes the considerations, criteria and requirements for a proposed Alabama Resources Information System (ARIS). Demonstration of the proposed system will be made in a continuation of the effort using a Datacraft 6024 and Tektronix 4200A remote terminal. These demonstrations will be followed by a build-up of the proposed system with the development of appropriate computer software coupled to appropriate hardware.

The report addresses the major work elements outlined in Appendix I. The proposed system is based on the McHarg approach of composite mapping technique and is planned as an evolutionary system adaptable to user needs and inputs and requirements of various federal agencies working with land use retrieval systems. Existing land use data manipulation subroutines are used where and when possible.

A basic demonstration of the system concept has been conducted with the aid of MERITS computer and terminal facilities of the Marshall Space Flight Center.

The ARIS system ultimately will be transferred to the Alabama Development Office for implementation within the State of Alabama.

APPENDIX I

Major Work Element: Demographic Characteristics

Reference Number: 923.01

The purpose of this element will be to analyze and distribute demographic data collected under FY 73 work program; e.g., U.S. Census Summary tape data by county and census county division (CCD), population projections, migration data developed by the Center for Business and Economic Research (CBER), etc. Trends to be analyzed at the State level will include total population change, age, sex and race characteristics, migration patterns--both internal and out of state--commuting patterns, and urban and rural shift. All characteristics will be displayed on maps, at least to the county level. Where feasible and desirable, the CCD level will be used to display data. Differences in trends among Regional Planning and Development Commissions will be considered and documented. Analyses and displays will be published and distributed for use in State planning to ADO, in planning by other State agencies and by Regional Planning and Development Agencies.

Major Work Element: Land Use System Development

Reference Number: 902.02

The enormous scope and complexity of the land use planning process, as it is envisioned in current legislative proposals, necessitates a highly sophisticated system to pull together, collate, and compare the vast amounts of data required for land use planning. This element will provide for a

continuing effort building upon last year's program and aimed at establishing a land use system which will be an on-going part of the land use planning process.

The land use system as envisioned would provide detailed data storage, retrieval and analysis. It will be patterned after the McHarg approach which is based on a composite mapping technique. This type of composite analysis is very similar to the map overlay technique with the exception that it is computerized. Varying criteria could be identified for analysis of the data within the system and varying values could be placed on the criteria and data for analysis. Several agencies, both state and federal, have or will be developing storage and retrieval systems, including the Alabama Revenue Department, NSAS, SCS, Department of Interior and the U. S. Department of Commerce. This effort will involve:

1. Analyses of the above mentioned efforts and those of other states to insure Alabama develops a system capable of meeting current and projected data processing needs.
2. Analysis of the needs of land use planning relative to a computerized system.
3. Preliminary indication of the manner and detail of data to be stored.
4. The type of computer manipulation capability required for land use planning.

It is expected that the necessary work will have been completed to indicate the type of system most appropriate for land use planning needs in Alabama.

Major Work Element: Automation of the Land Use System

Reference Number: 902.03

Based on the needs and requirements detailed in the previous work element, this effort will involve the development of an automated land use system capable of interpreting and displaying land use planning data. This will be a demonstration project. It is not expected that the final system will be developed out of this effort for much will depend upon the efforts and determination of federal agencies working with land use retrieval systems. This work will involve:

1. Description of the automated system.
2. Development of procedures for inputting data.
3. Demonstration of the system using available land use data.

APPENDIX II

ACQUIRED SOFTWARE

Bureau of the Census:

Daulist 1 Display Program
Daulist 2 Display Program
Daulist 3 Display Program
Daulist 4 Display Program
Fixdime Correction Program

Laboratory for Computer Graphics and Spatial Analysis:

CALFORM Version I Computer Mapping Program
SYMAP Version V Computer Mapping Program

National Center for Health Statistics:

POPSIM, FORTRAN 4 Computer Program

Tektronics, Inc.:

Plot 10/Terminal Control System
Plot 10/Advanced Graphing II
Plot 10/Preview Routines for Calcomp Plotters

APPENDIX III

ACQUIRED DATA

The following list of materials have been ordered to facilitate development of the Alabama Resource Information System.

A. All Available Topographic Maps of Alabama:

1. 1:24,000 Quadrangles
2. 1:62,500 Quadrangles
3. 1:250,000 Series
4. 1:500,000
5. 1:1,000,000

B. Special Publications of Geologic Survey of Alabama:

1. Special Reports, Selected Phenomena
2. County Reports
3. Monograph, Forest of Alabama
4. Bulletins Related to County Study Areas
5. Circulars Related to County Study Areas
6. Informatic[illegible]eries, Water Related
7. Selected Geologic Maps of County Areas
8. Ozalid Copies of Alabama Base Map 1:250,000, 4 Sections

C. Soil Surveys for the Following Counties:

1. Mobile
2. Baldwin
3. Limestone
4. Sumter
5. Pickens
6. Morgan
7. Elmore
8. Greene
9. Madison
10. Montgomery
11. Marshall
12. Escambia
13. Autauga

D. Gridded Mylar Overlays For:

1. 1:250,000 in 4 Sections
2. Zone 16 UTM Grid
3. Scale:
   a. 1:250,000
   b. 1:63,360
   c. 1:62,500
   d. 1:24,000
   e. 1:20,000

E. Photographic Resources

1. Soil Conservation and Stabilization Service Maps for Each County Study Area
2. Bands 5 and 7 ERTS Alabama Coverage

F. Highway Department, County Maps of Alabama, All Scales

G. Computer Tapes and Copies of 1970 U.S. Census of Alabama

H. Data from University of Alabama on Land Use Research (ERTS and Low Level Aerial Photography)

I. Land Ownership Maps by County

APPENDIX IV

ALABAMA STANDARD LAND USE CLASSIFICATION
(First, Second and Third Levels)

	Function Code	Numeric Code	Alphabetic Code
Urban and Built-Up	0,1,2,3,5,6,7,8,9	1	U
Residential	2	11	UR
Single Family	2	111	URS
Duplex (2 dwelling units in one structure)	2	112	URD
Multi-family (more than 2 dwelling units in one structure)	2	113	URM
Mobile Home Park	2	114	URP
Mobile Home (single)	2	116	URT
Other Residential	2	115	URO
Commercial	9	12	UC
Retail Trade	9	121	UCR
Wholesale Trade	9	122	UCW
Business Services	9	123	UCB
Consumer Services	9	124	UCS
Other Commercial	9	125	UCO
Industrial	9	13	UI
Light Industry	9	131	UIL
Heavy Industry	9	132	UIH
Transportation	1	14	UT
Motor Vehicle (roads & highways)	1	141	UTM
Rail	1	142	UTR
Air	1	143	UTA
Water	1	144	UTM
Communications	1	145	UTC
Utilities	1	146	URU
Public and Institutional	0,3,5,6,7,8	15	UP
Public	0,3,5,6,7,8	151	UPP
Semi-public	0,3,5,6,7,8	152	UPS
Institutional	0,3,5,6,7,8	153	UPI
Open Land	4	16	UO
Open Land	4	161	UOL
Mixed Urban	0,1,2,3,4,5,6,7,8,9	17	UM
Mixed Urban	0,1,2,3,4,5,6,7,8,9	171	UMX

	Function Code	Numeric Code	Alphabetic Code
Agricultural	9	2	A
Cropland and Pasture	9	21	AC
Active Cropland	9	211	ACR
Idle Cropland	9	212	ACI
Pasture	9	213	ACP
Rotated Crop & Pasture	9	214	ACC
Horticultural Areas	9	22	AH
Orchards	9	221	AHO
Vineyards	9	222	AHV
Groves	9	223	AHG
Bush Fruit	9	224	AHB
Other Horticulture	9	225	AHO
Feeding Operations	9	23	AF
Poultry Feeding	9	231	AFP
Cattle Feeding	9	232	AFC
Swine Feeding	9	233	AFS
Other Feeding Operations	9	234	AFO
Other Agricultural Land	9	24	AO
Other Agricultural Land	9	241	AOL
Forestland	4	3	F
Forest	4	31	FF
Deciduous Forest	4	311	FFD
Coniferous Forest (evergreen)	4	312	FFC
Mixed Forest	4	313	FFM
Bushland	4	32	FB
Bushland	4	321	FBB
Developing Bushland	4	322	FBD
Tree Plantations	9	33	FT
Tree Plantations	9	331	FTP
Other Forestland	4	34	FO
Other Forestland	4	341	FOF
Water	4	4	W
Streams	4	41	WS
Rivers	4	411	WSR
Creeks	4	412	WSC
Canals	4	413	WSL

	Function Code	Numeric Code	Alphabetic Code
Reservoirs & Lakes (man-made)	4	42	WR
Reservoirs & Lakes	4	431	WRR
Ponds	4	432	WRP
Coastal	4	44	WC
Gulf	4	441	WCG
Bay	4	442	WCB
Estuary	4	443	WCE
Other	4	444	WCO
Non-Forested Wetland	4	5	N
Vegetated	4	51	NV
Other Wetland	4	511	NVO
Tidal Flats	4	512	NVT
Marshes	4	513	NVM
Bare Wetlands	4	52	NB
Bare Wetlands	4	521	NBA
Bareland	4	6	B
Beaches	4	61	BB
Beaches	4	611	BBA
Exposed Rock	4	62	BE
Exposed Rock	4	621	BER
Extractive	4	63	BX
Strip Mines	4	631	BXS
Quarries	4	632	BXO
Tailings	4	633	BXT
Other Extractive Use	4	634	BXO
Other Bareland	4	64	BO
Other Bareland	4	641	BOB